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Ellingson et al.

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[45] **Date of Patent: Aug. 28, 1984**

[54] **ANTENNA TOWER ASSEMBLY AND METHOD OF ATTACHING ANTENNAS**

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[73] Assignee: **Polar Research, Inc.**, Thief River Falls, Minn.

[21] Appl. No.: **272,313**

[22] Filed: **Jun. 10, 1981**

[51] **Int. Cl.**[3] **H01Q 1/12; H01Q 3/04**

[52] **U.S. Cl.** **343/766**; 343/890; 52/114

[58] **Field of Search** 52/65, 110, 114, 148, 52/649, 653, 655; 343/757, 758, 763, 766, 879, 882, 890, 892; 248/218.4, 514

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,290,692	7/1942	Lindenblad	343/879
2,623,999	12/1952	Kulikowski	343/758
2,642,754	6/1953	Conti	52/114
2,654,031	9/1953	Mullins	343/765
3,146,452	8/1964	Rose	343/758
3,246,431	4/1966	Faerber	52/65
3,541,570	11/1970	Onnigian	343/704
3,790,950	2/1974	Smith et al.	343/879
4,293,861	10/1981	Winegard	343/766

FOREIGN PATENT DOCUMENTS

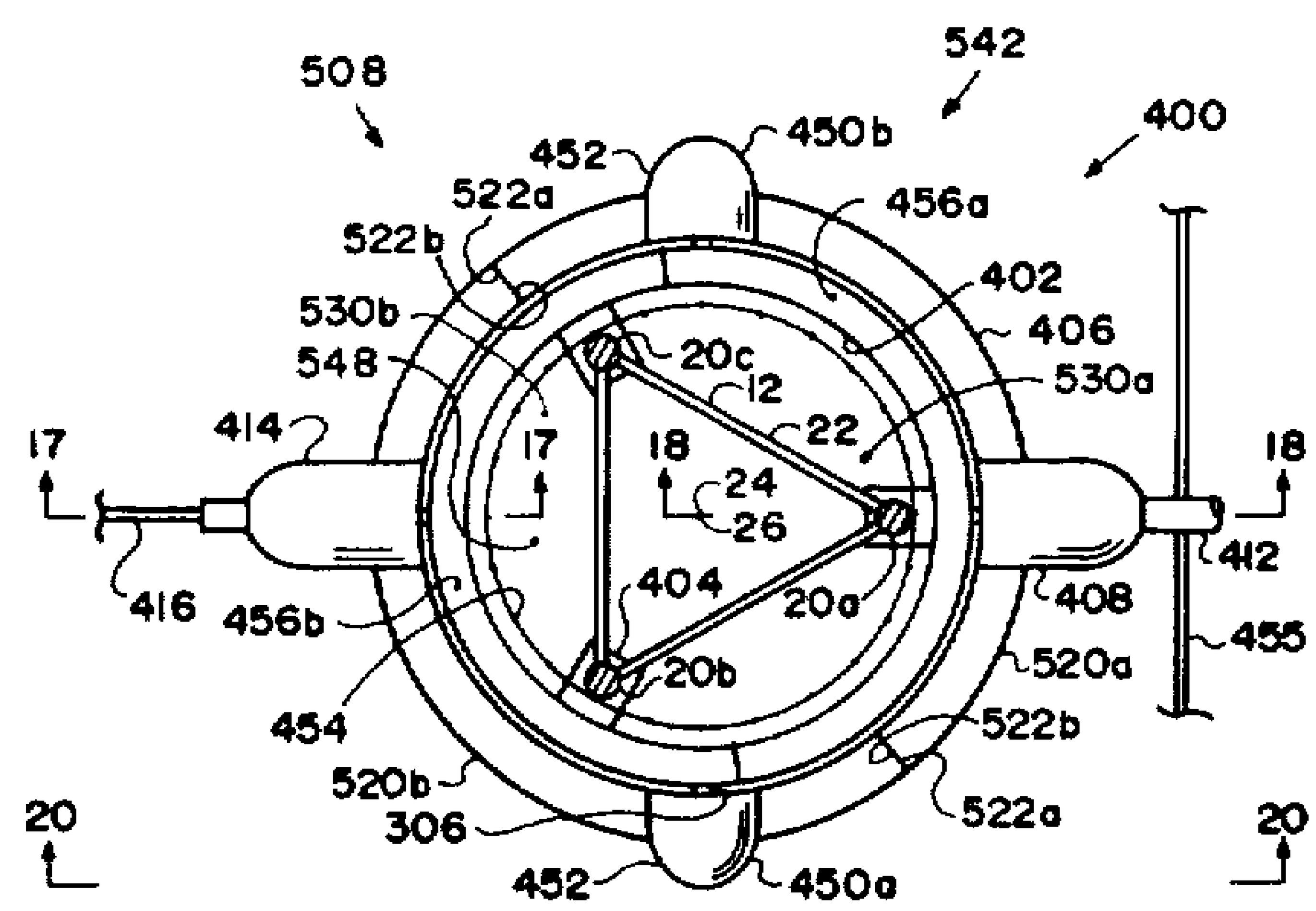
1466609	2/1969	Fed. Rep. of Germany	343/763
808961	2/1959	United Kingdom	343/DIG 1

Primary Examiner—Eli Lieberman
Attorney, Agent, or Firm—Wendell E. Miller

[57] **ABSTRACT**

The present invention provides an apparatus and a method for mounting and both separate and selective rotational positioning of a plurality of separate antennas, or search devices, on a single tower. Three of the preferred embodiments for use in mounting and rotationally positioning antennas or search devices include an antenna-mounting ring, or search-device mounting ring (**142, 292,** or **406**) that is attached to the tower (**12**) by a plurality of support rollers (**160, 219,** or **306**). The support rollers are operatively attached to the tower or to the antenna-mounting ring and supportingly engage a circumferential groove (**150, 298,** or **430**) which is located in either the antenna-mounting ring, or in a tower-attaching ring (**402**) that is interposed between the antenna-mounting ring and the tower. The preferred embodiment for use in mounting of antennas of the type that are rotationally positioned and then permanently left in that rotational position utilizes two vertically-spaced and arcuately-shaped mounting portions (**42*a*** and **42*b***).

30 Claims, 26 Drawing Figures



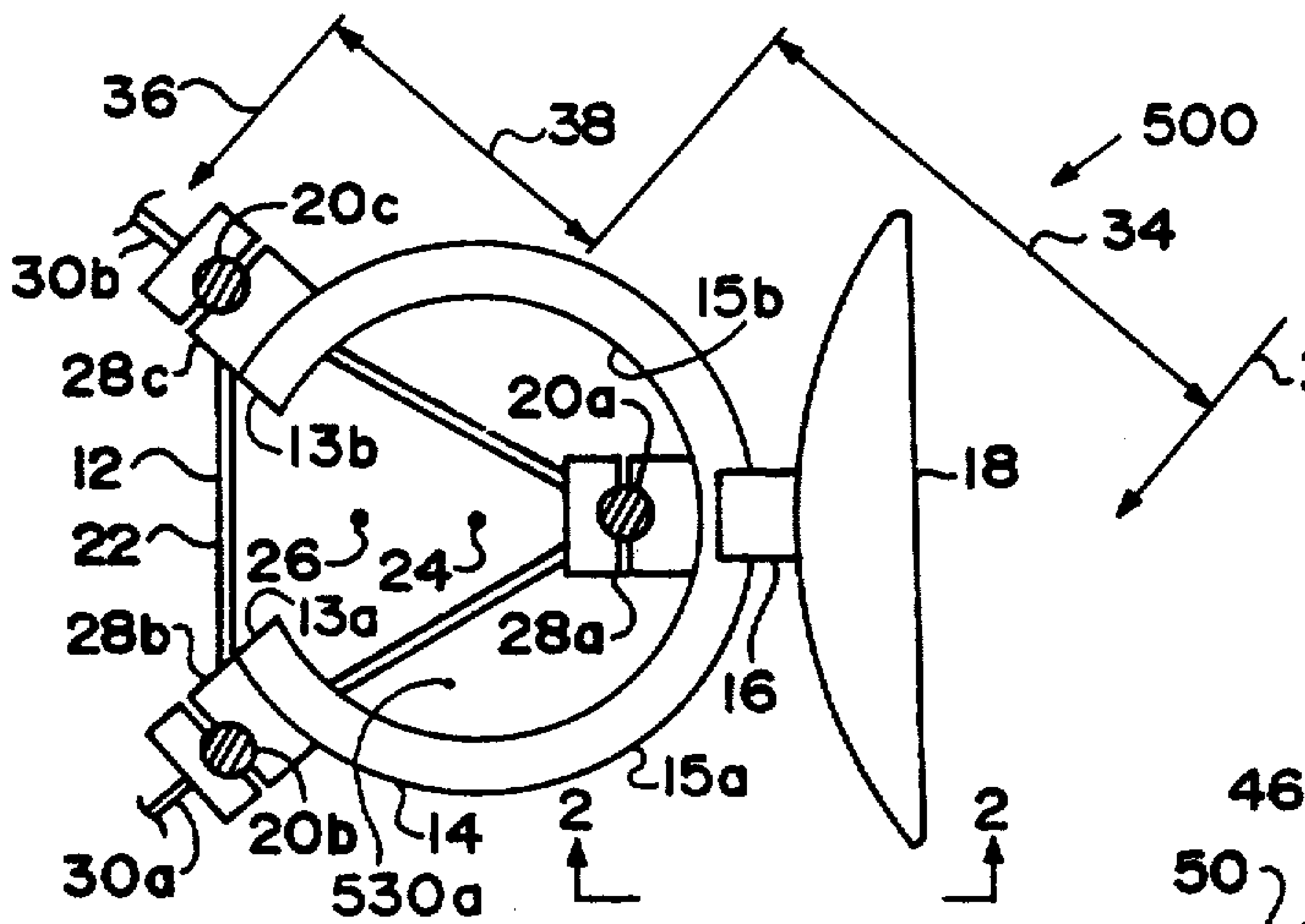


FIG. 1

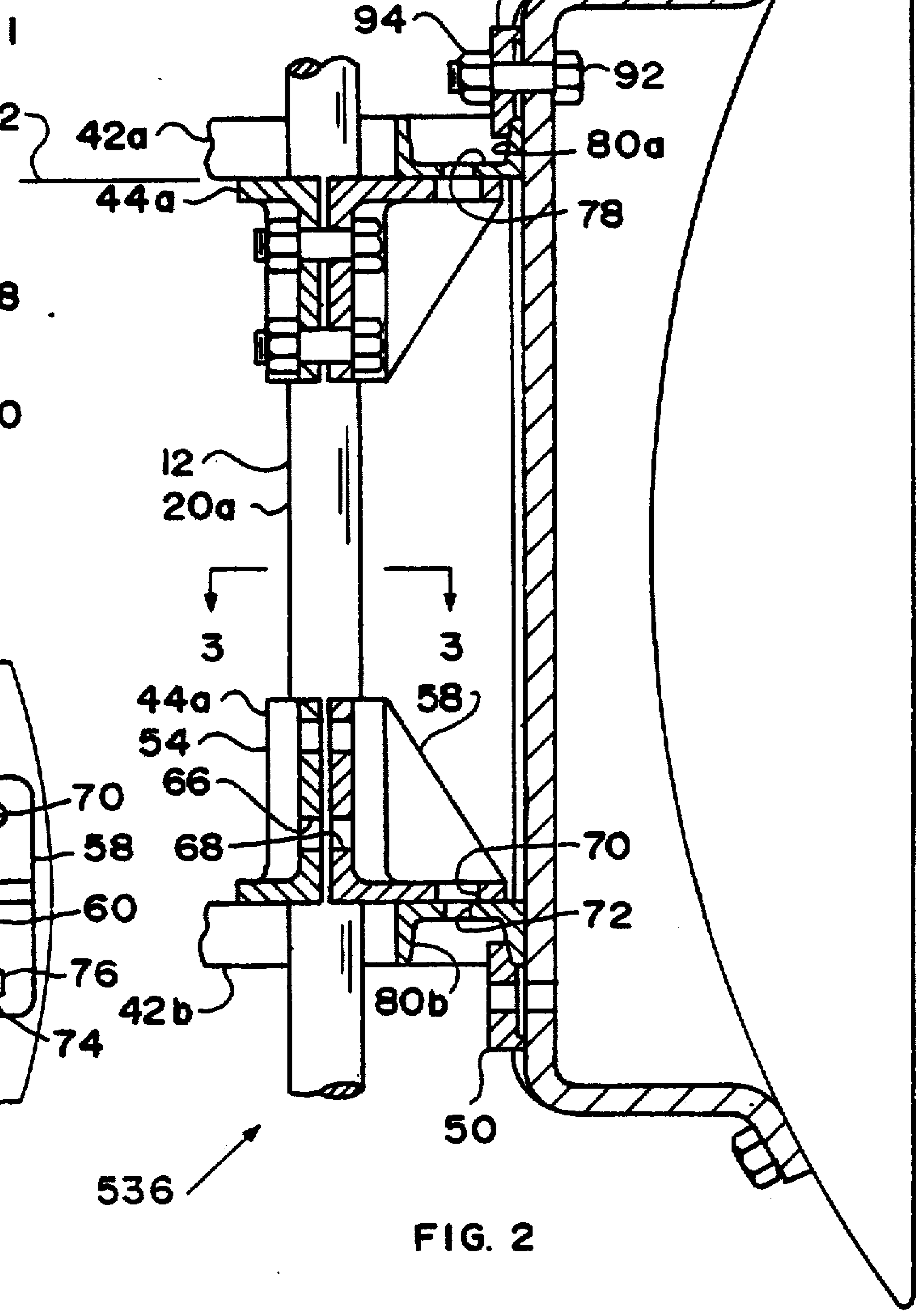


FIG. 2

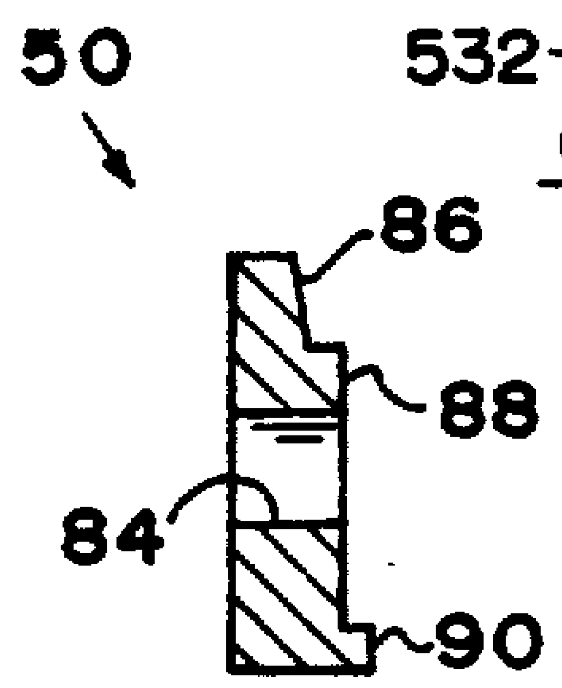


FIG. 4

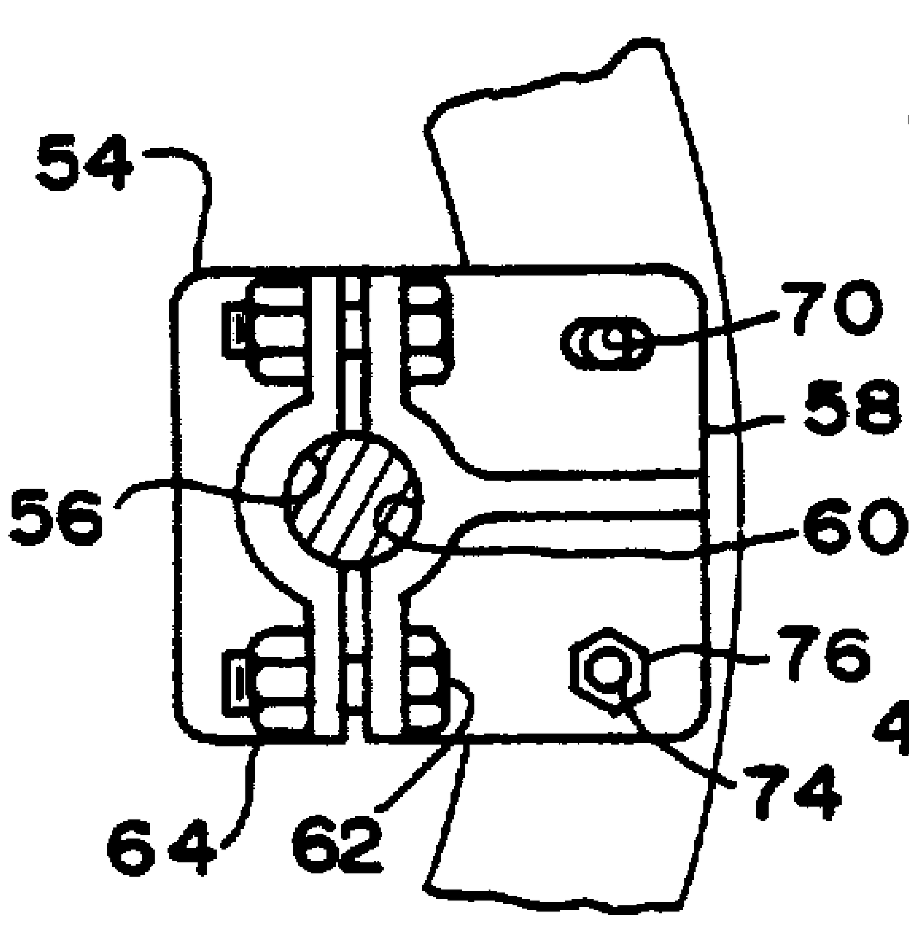


FIG. 3

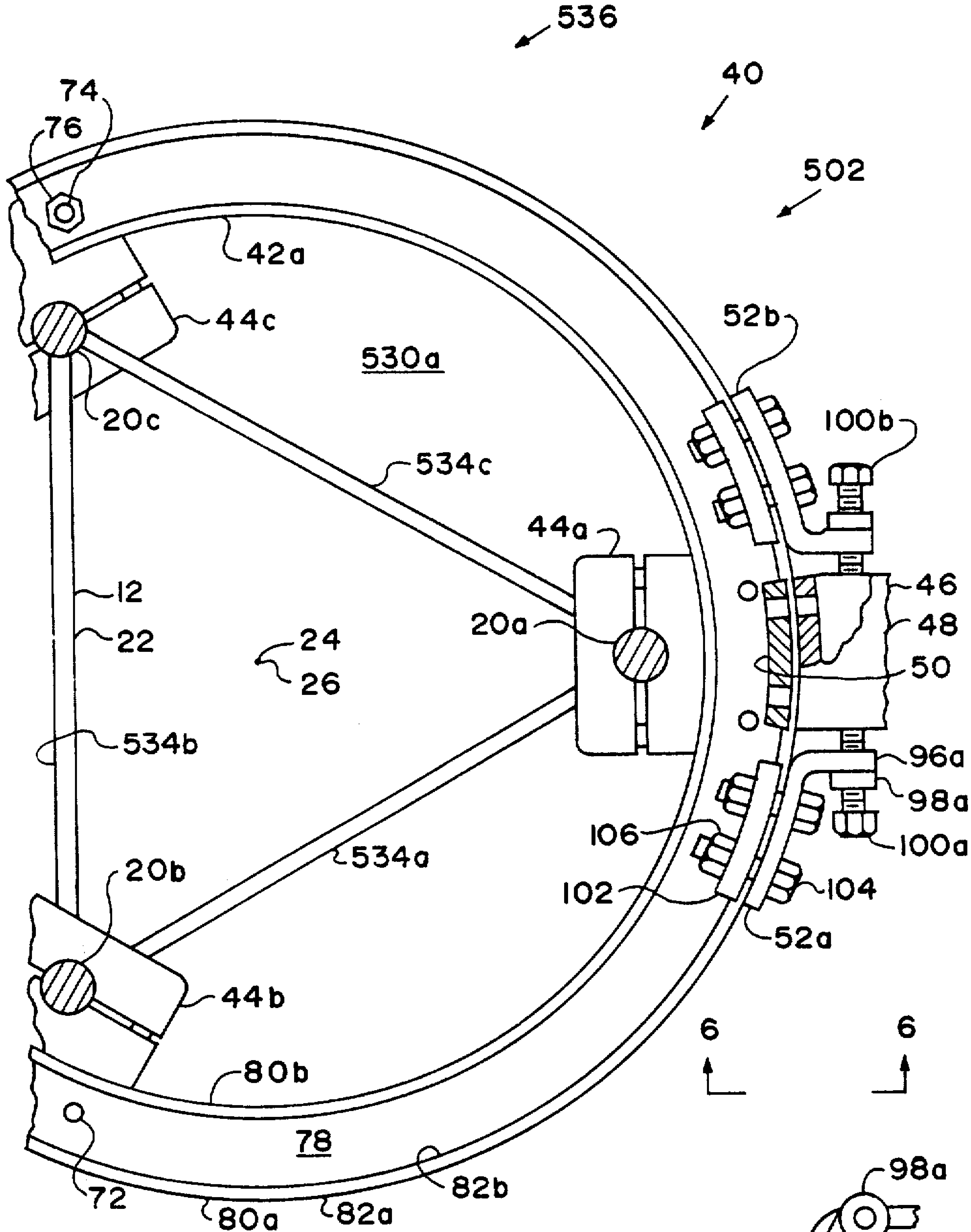

536
40
502
74
76
42a
44c
530a
52b
20c
100b
534c
44a
46
12
20a
48
22
24
26
50
534b
96a
98a
106
100a
534a
20b
102
104
52a
44b
6
6
80b
78
72
82b
80a
82a

FIG.5

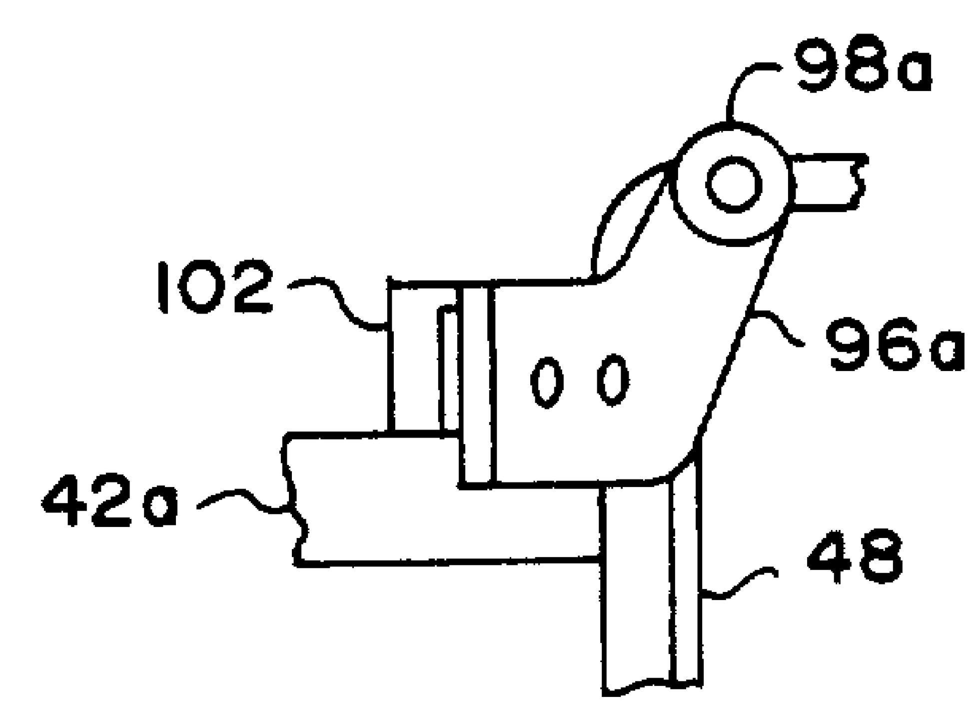

98a
102
96a
42a
48

FIG. 6

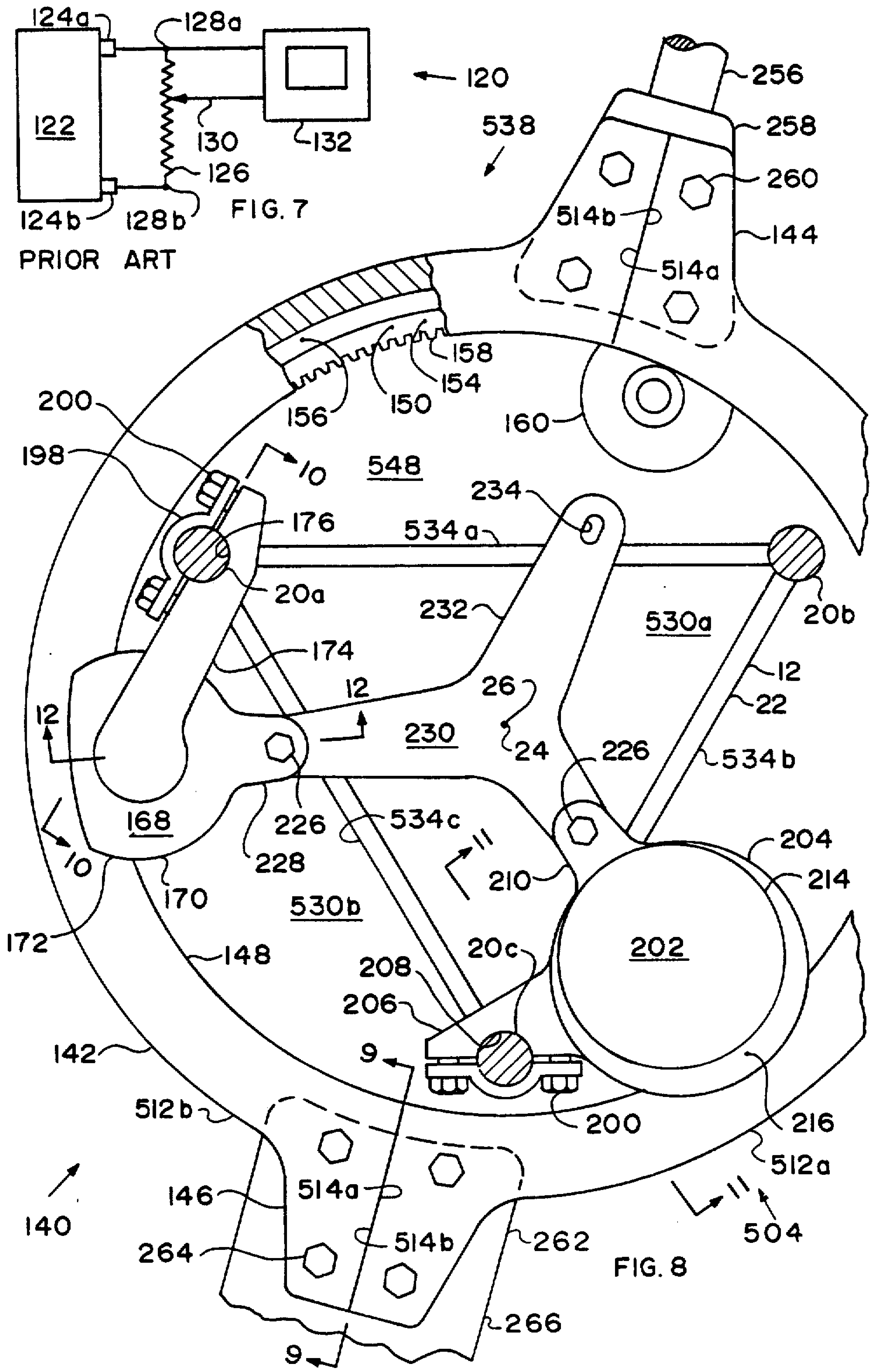


FIG. 7

PRIOR ART

FIG. 8

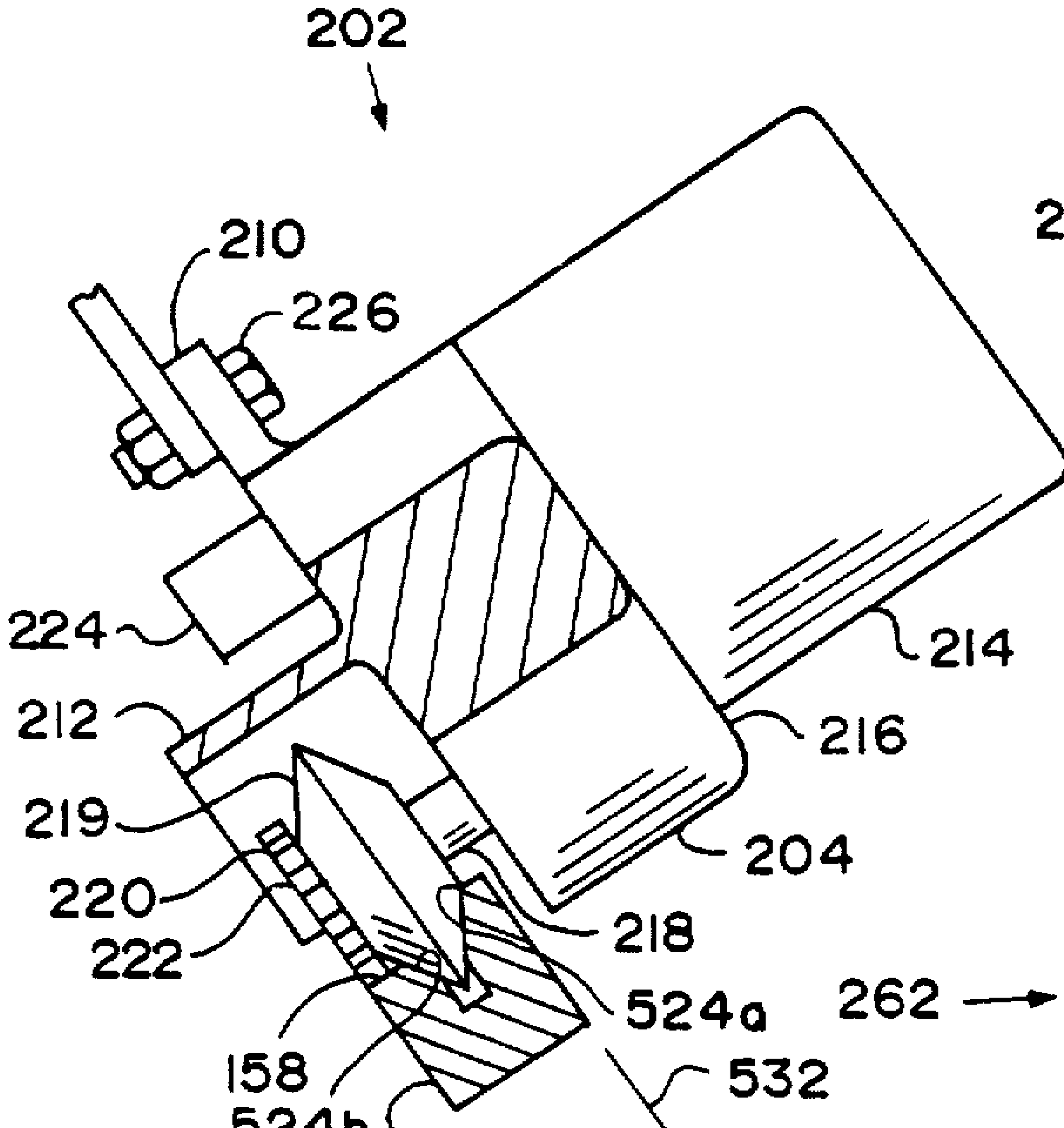


FIG. 11

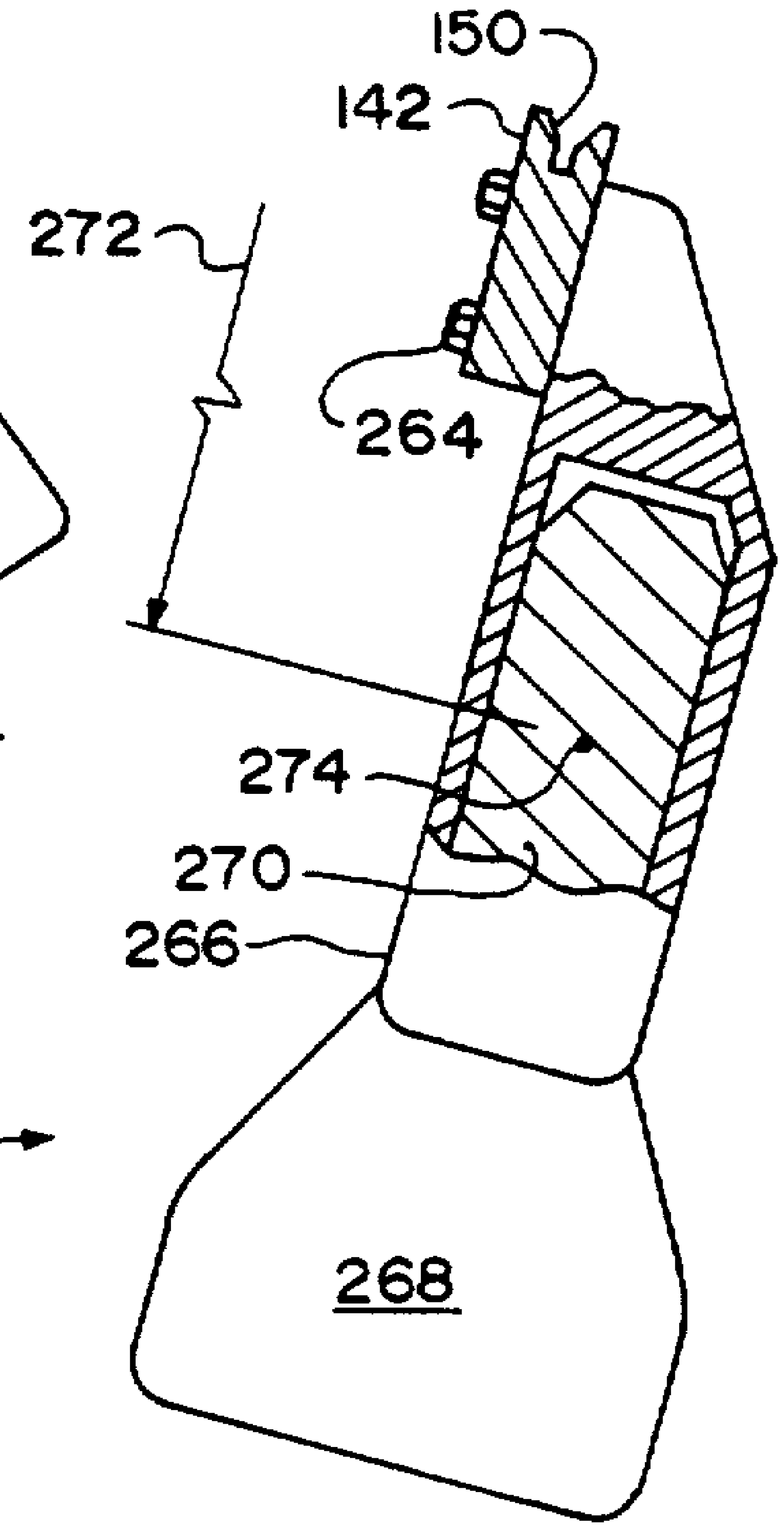


FIG. 9

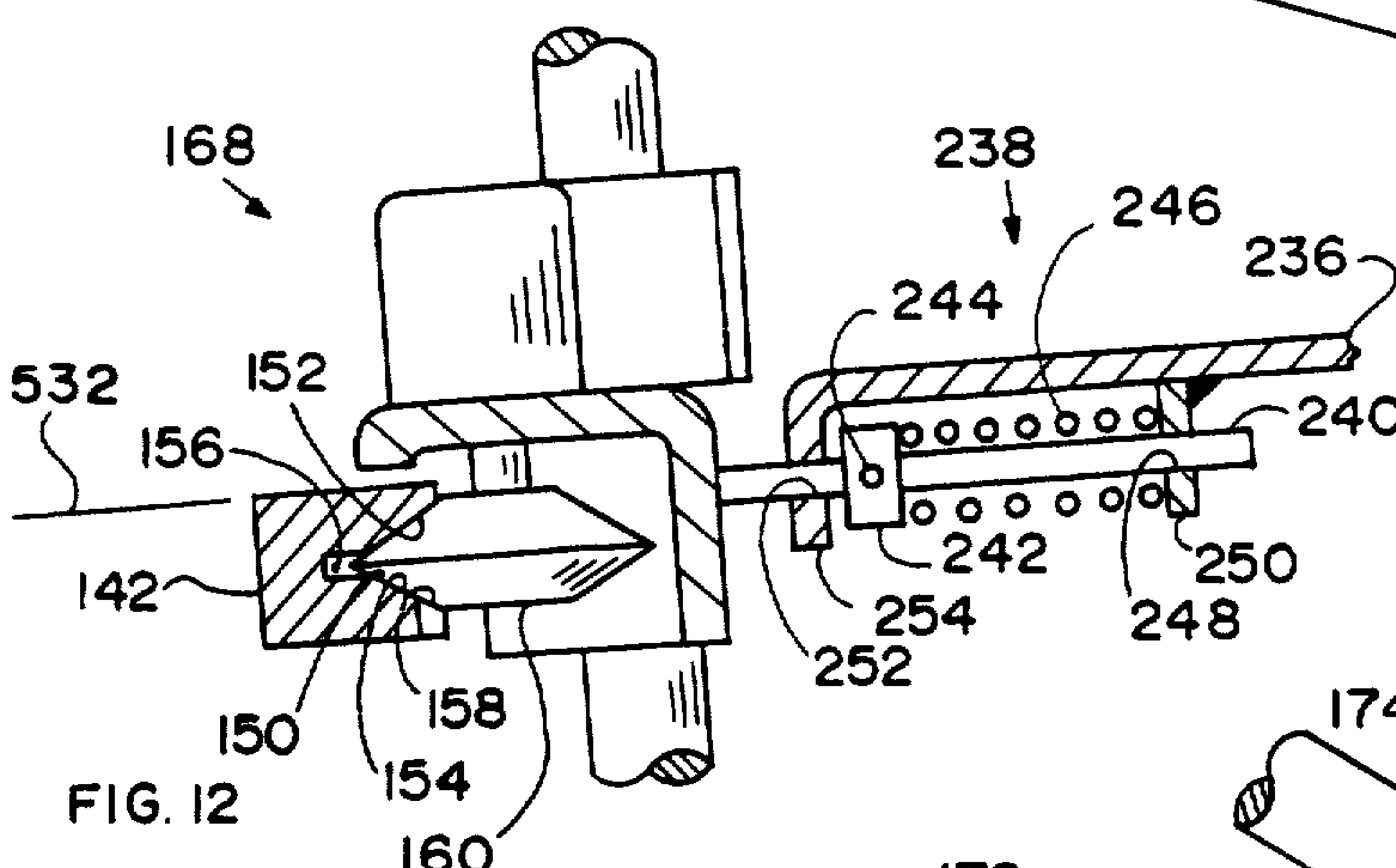


FIG. 12

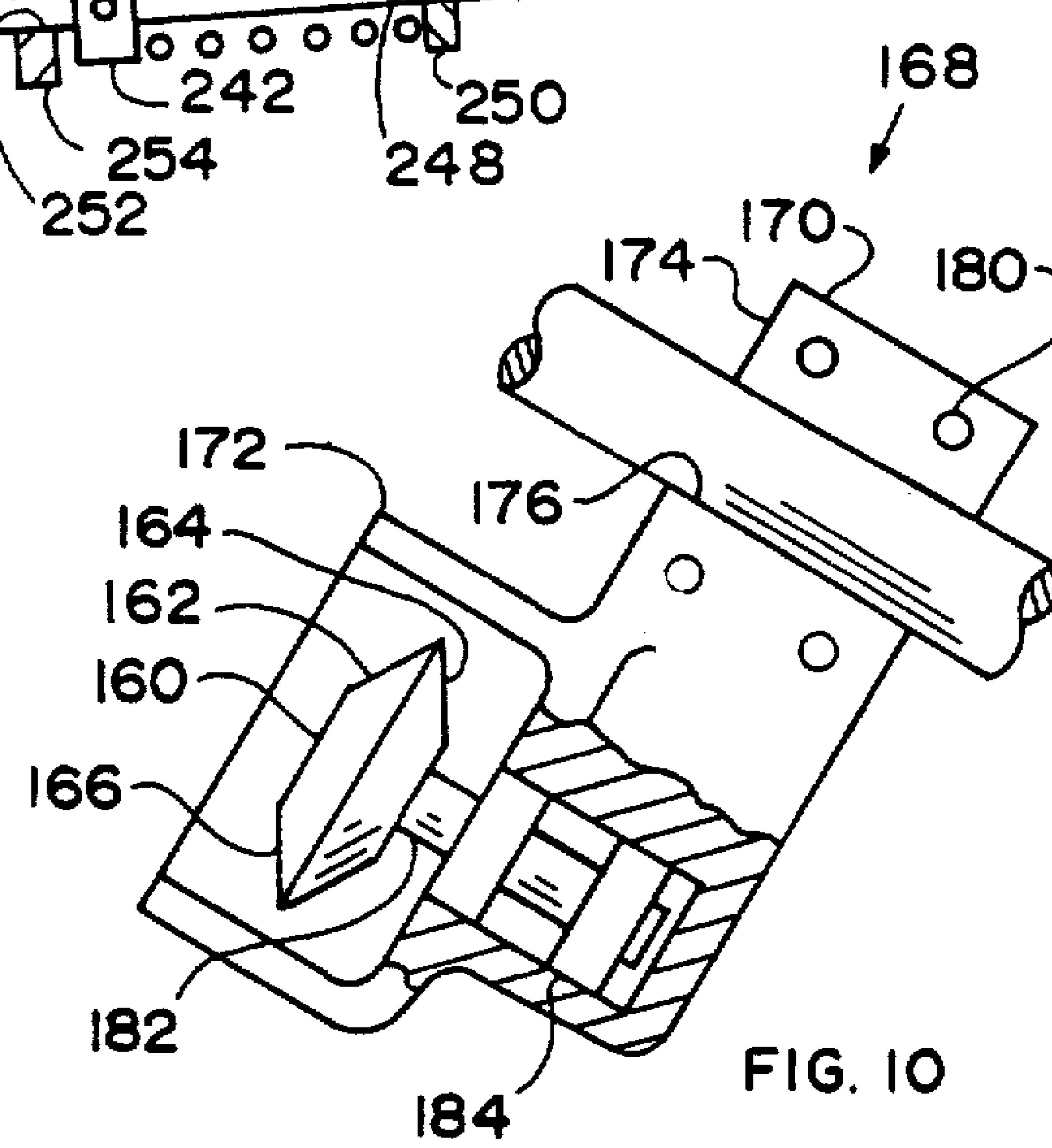


FIG. 10

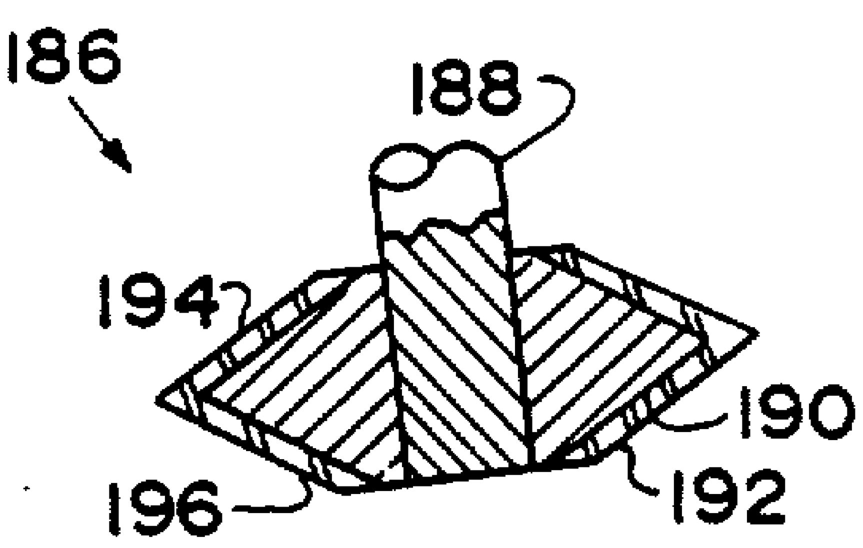


FIG. 13

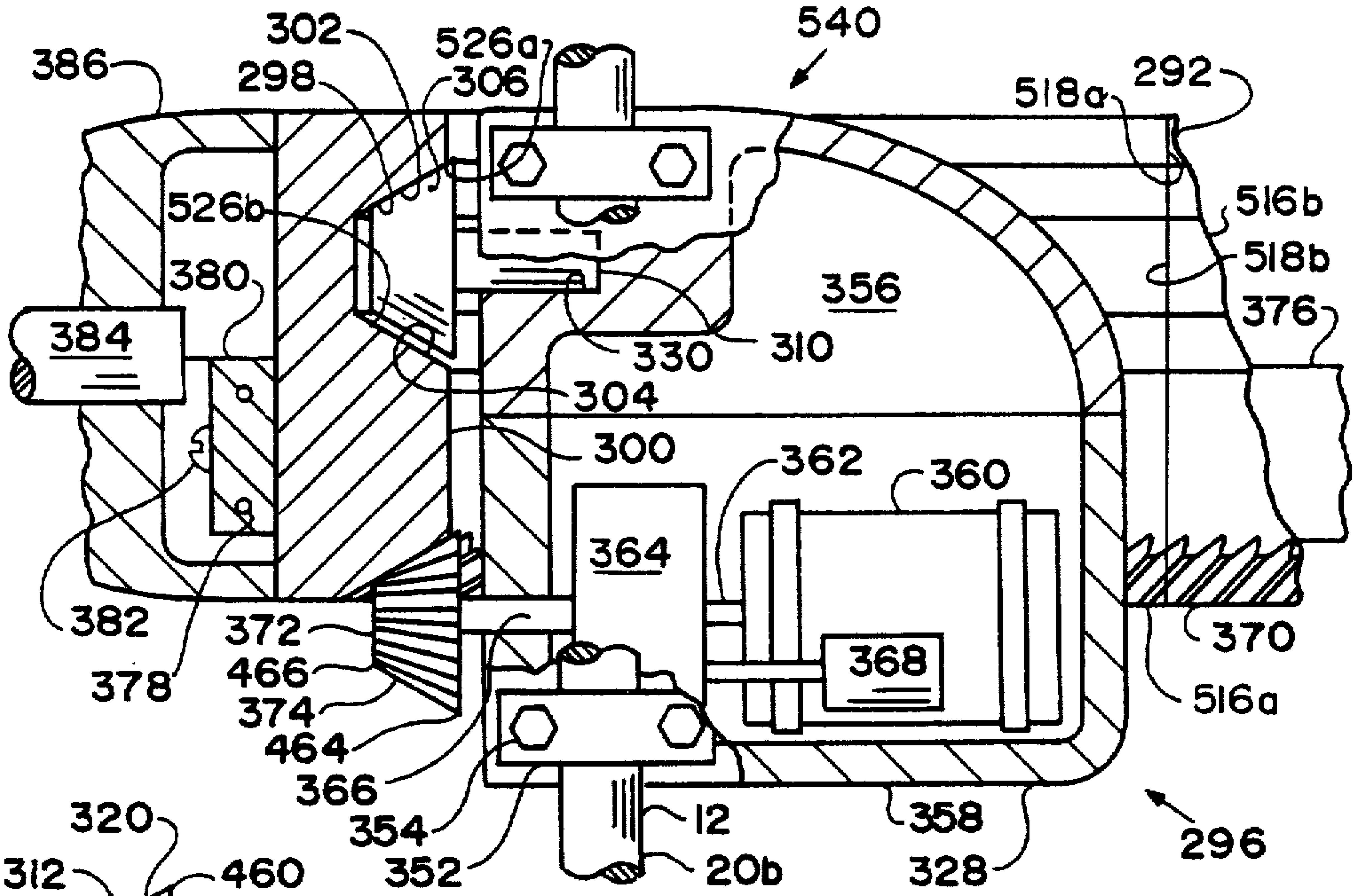


FIG. 14

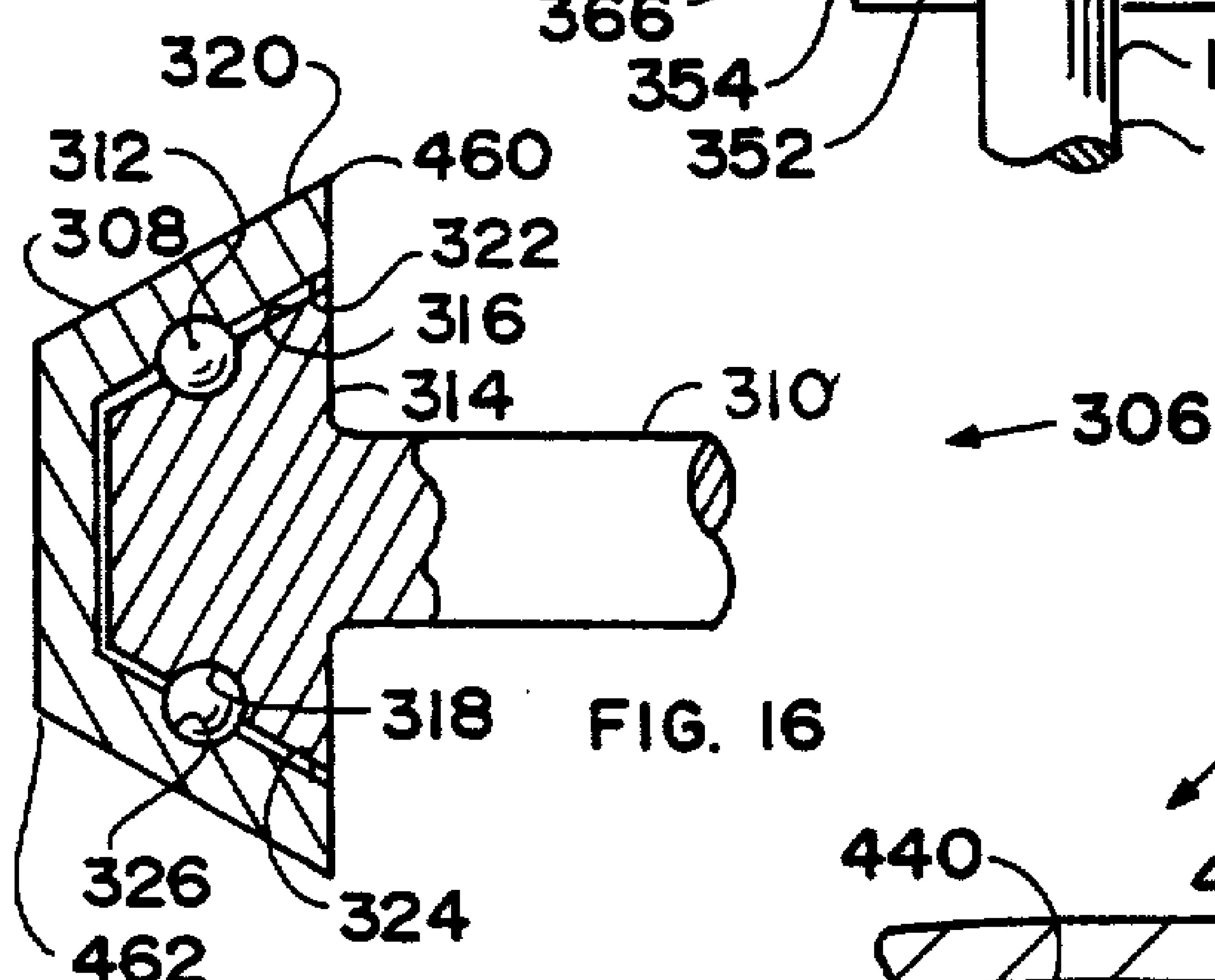


FIG. 16

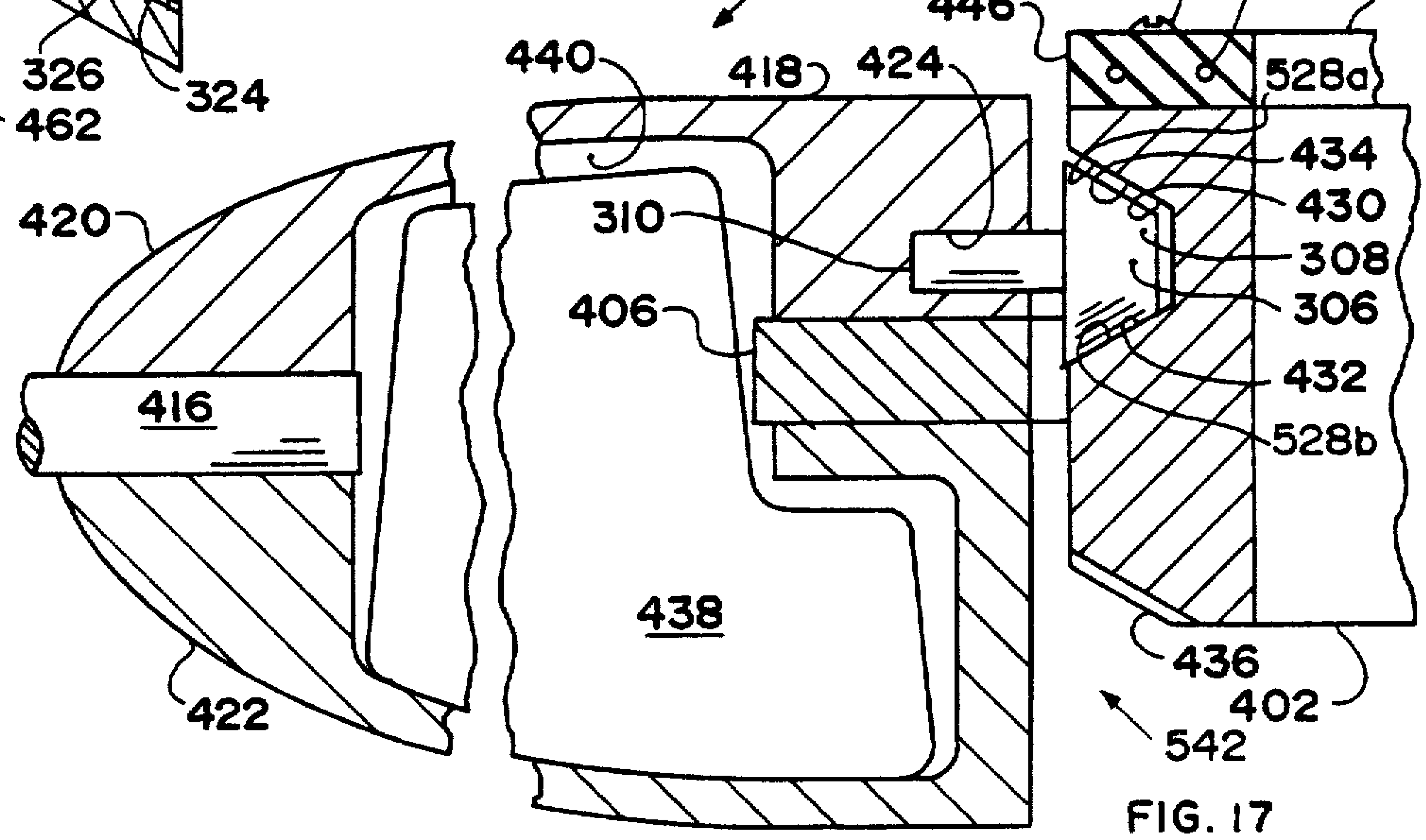
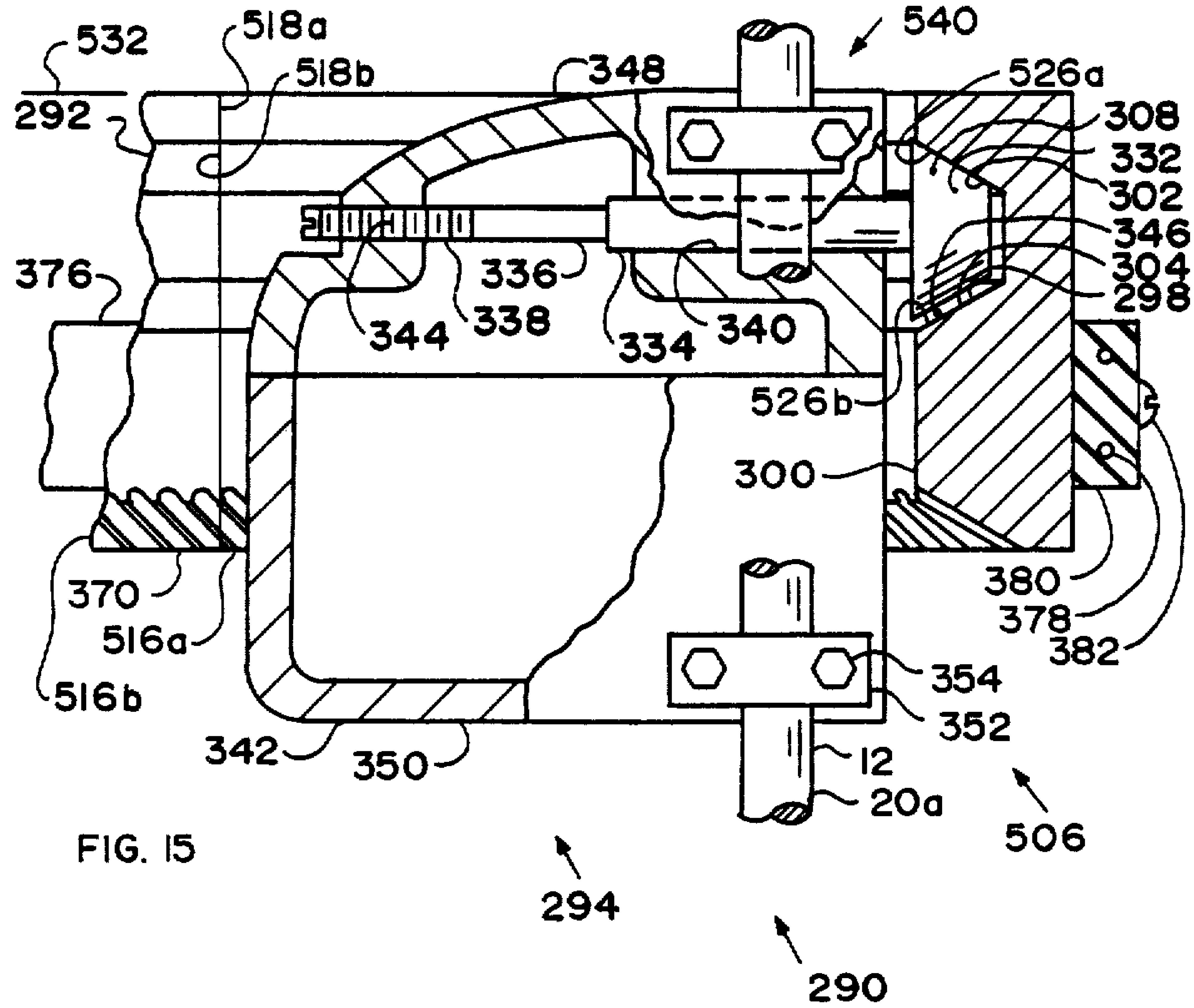


FIG. 17


532
518a
518b
292
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540
526a
308
332
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526b
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516b
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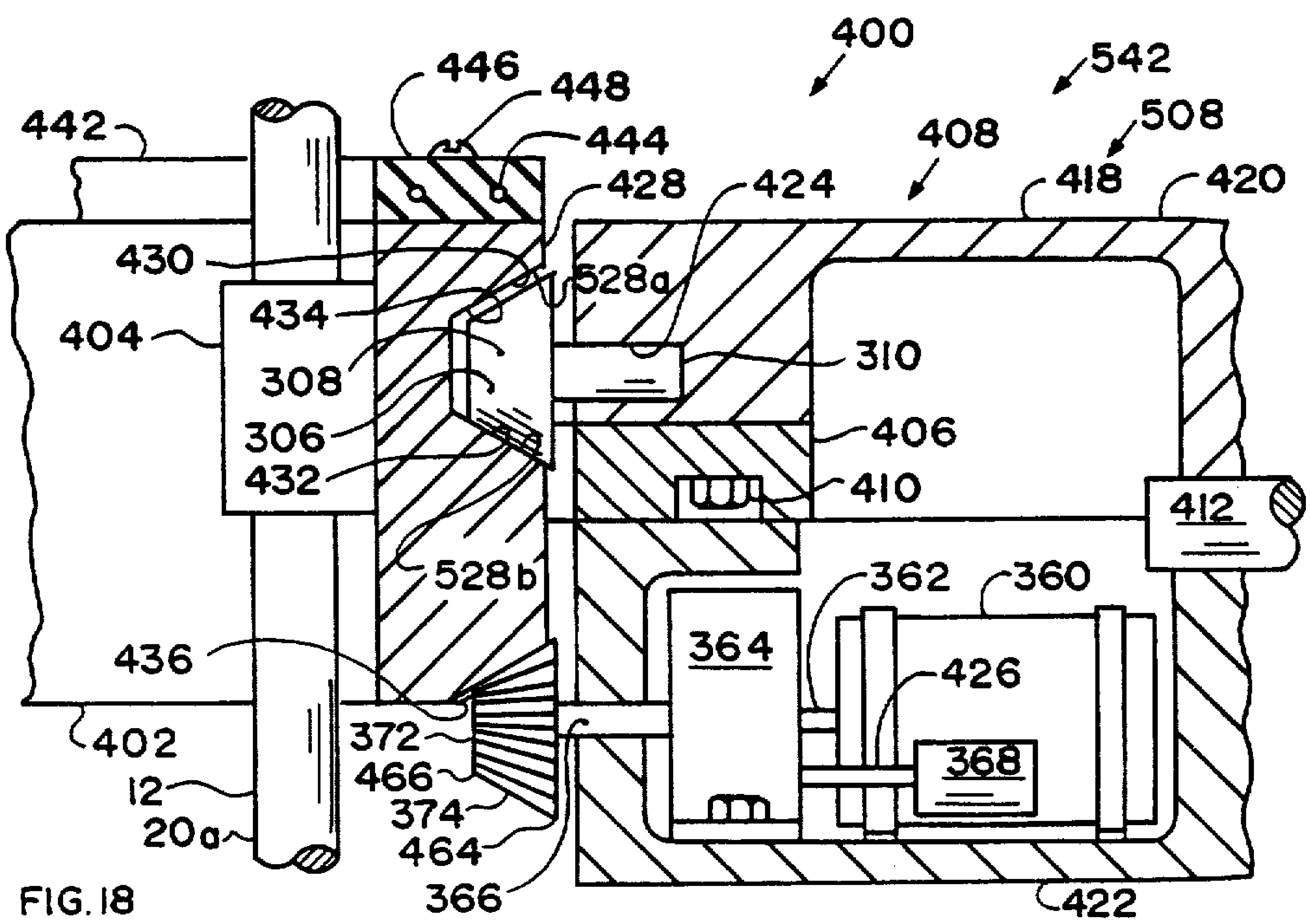
382
354
352
342
350
12
20a
506
294
290

FIG. 15


400
542
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528a
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406
432
410
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528b
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360
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436
426
372
402
466
368
12
374
20a
464
366
422

FIG. 18

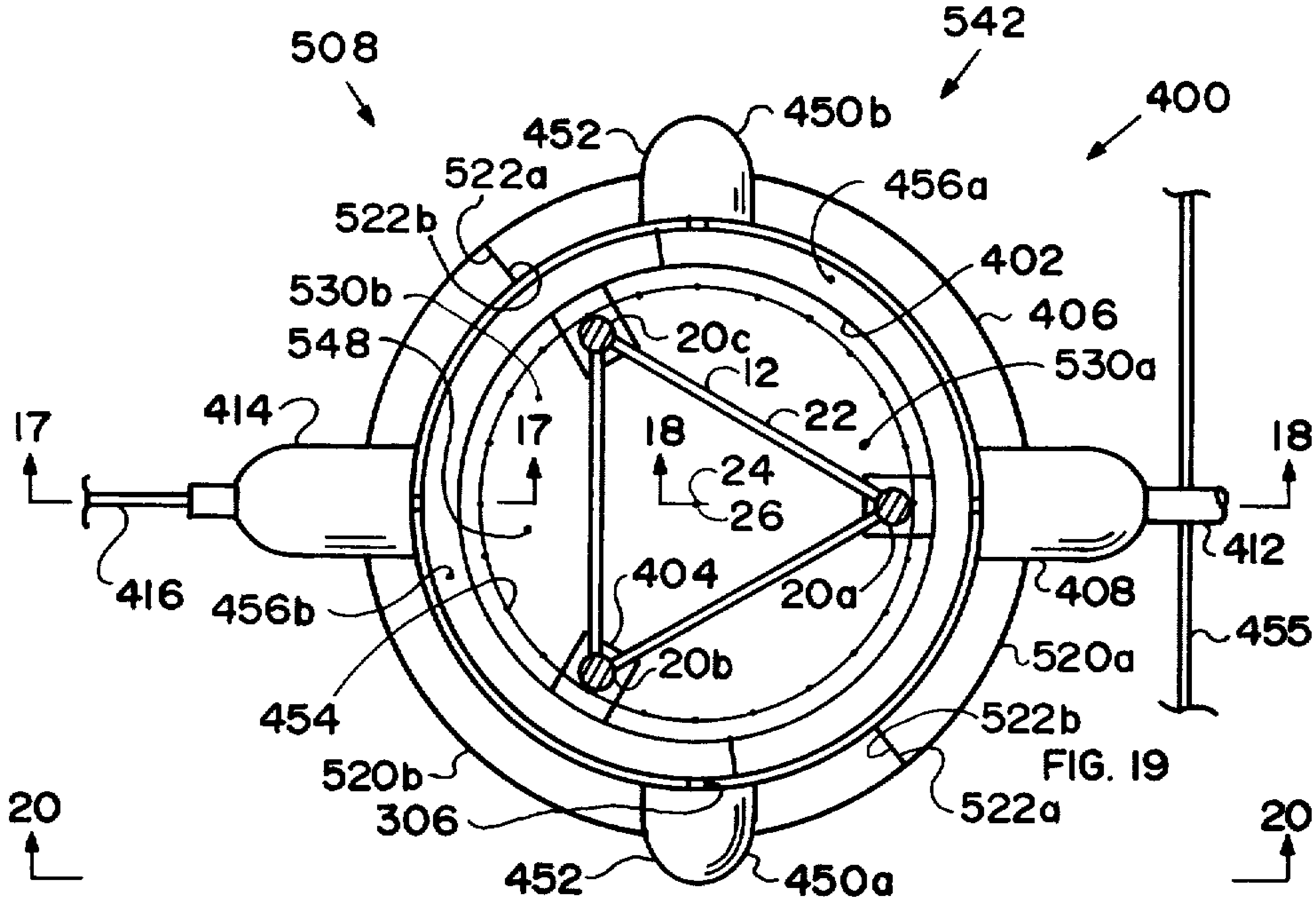

FIG. 19

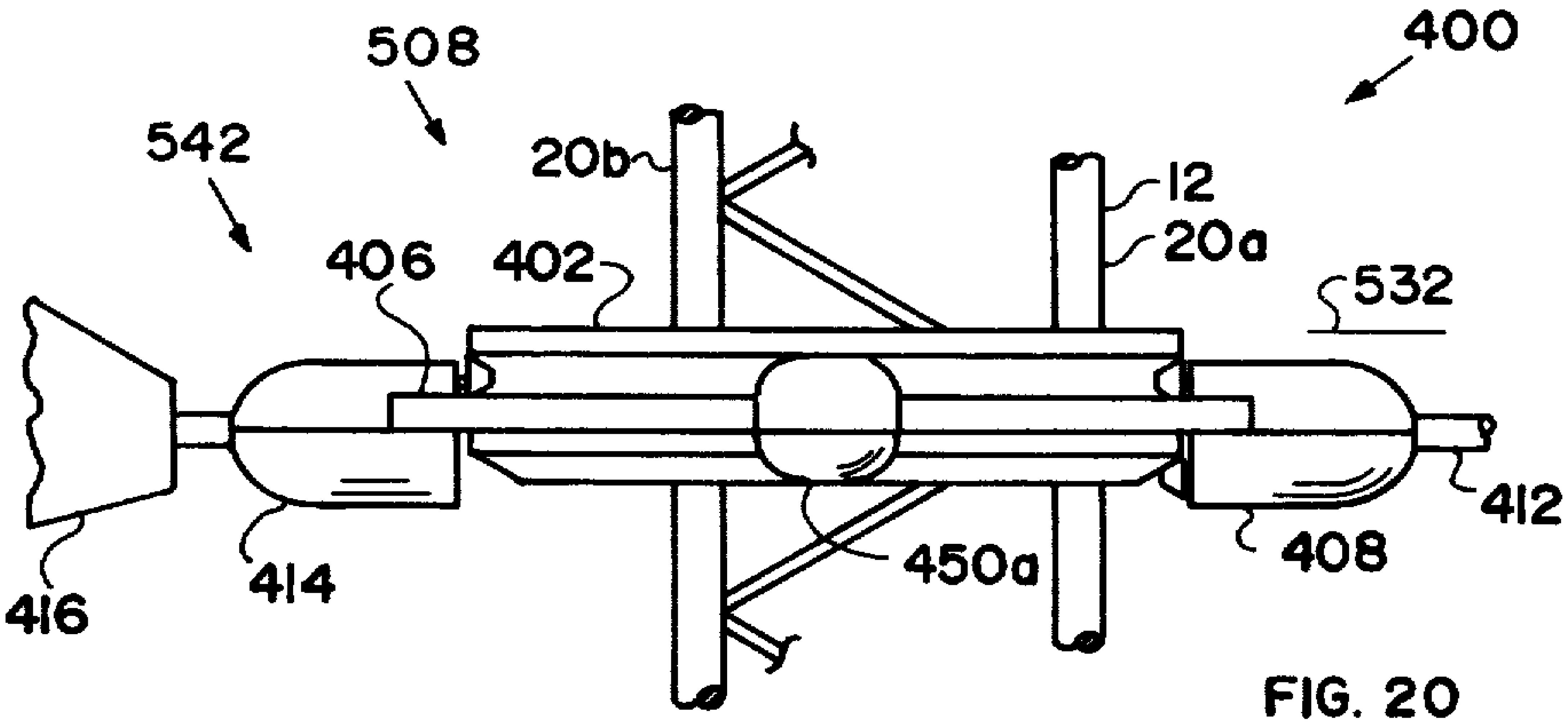

FIG. 20

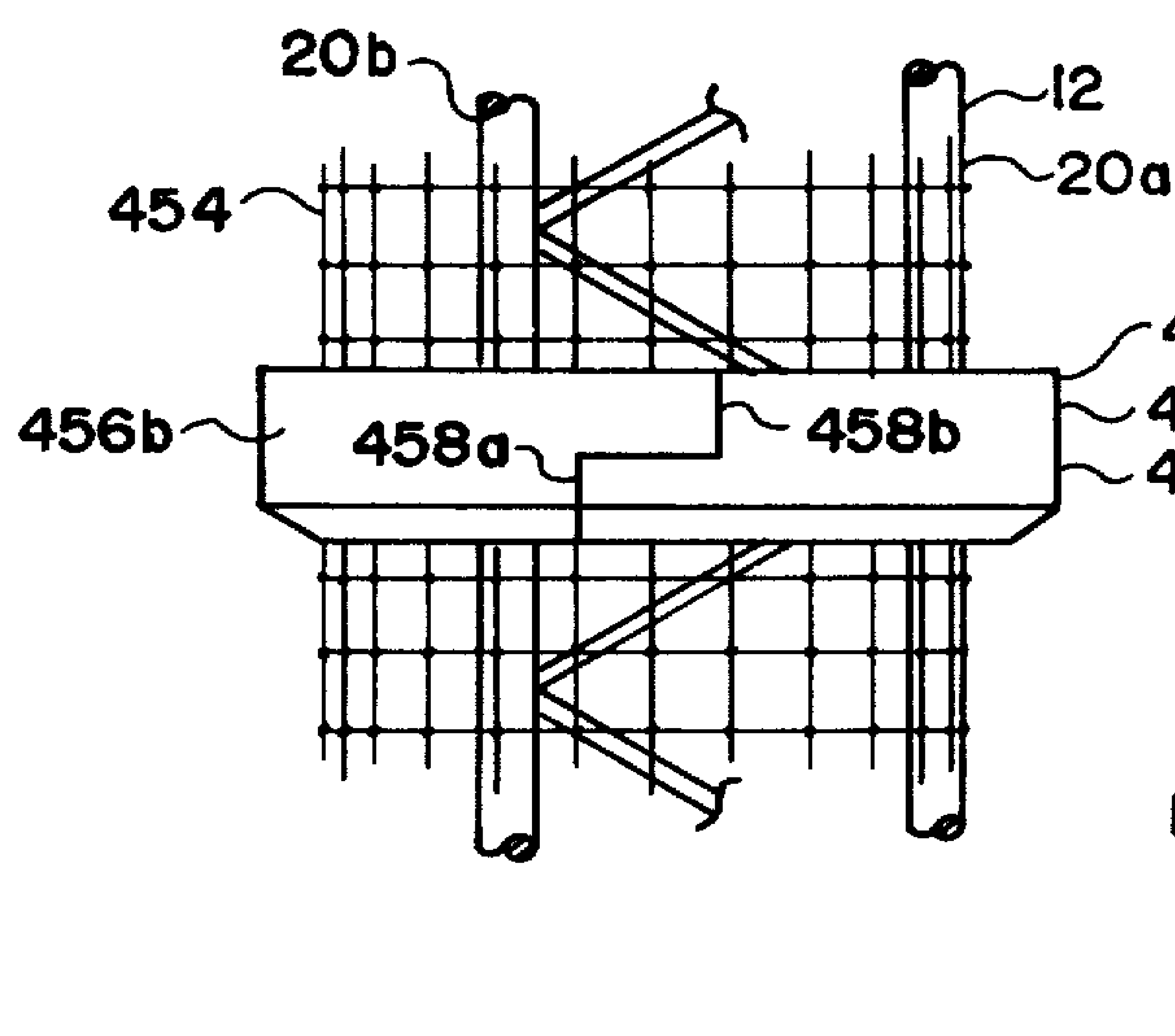

FIG. 21

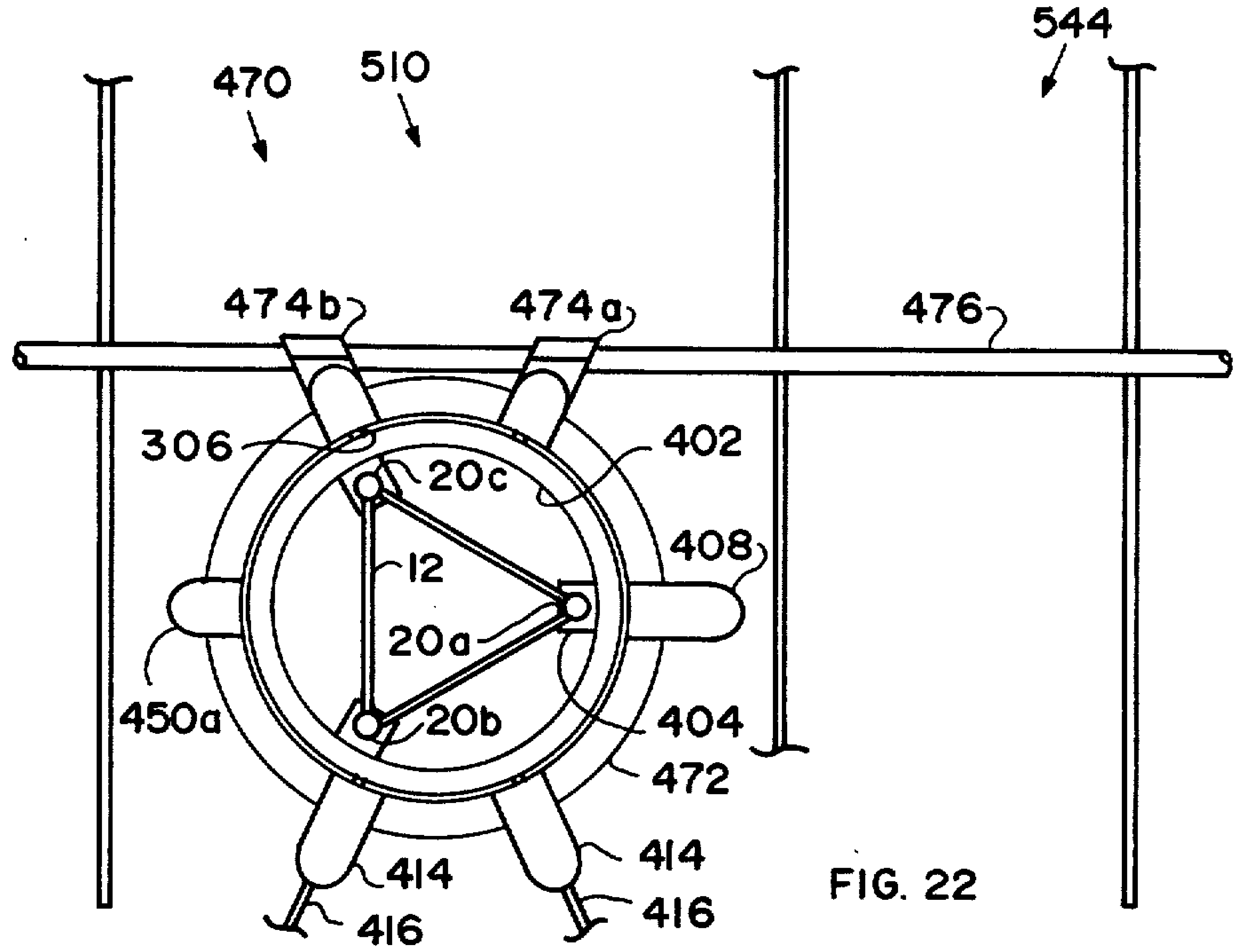

FIG. 22

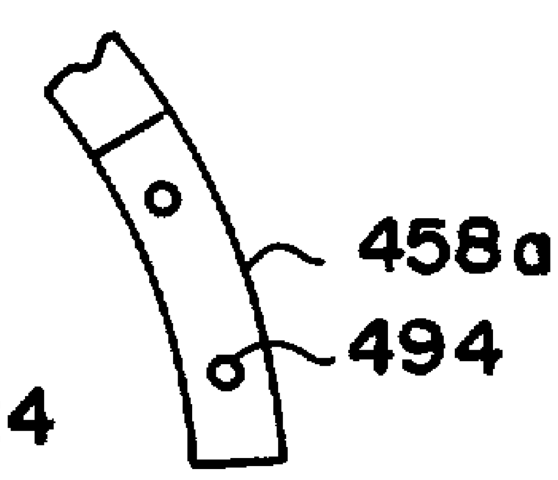

FIG. 24

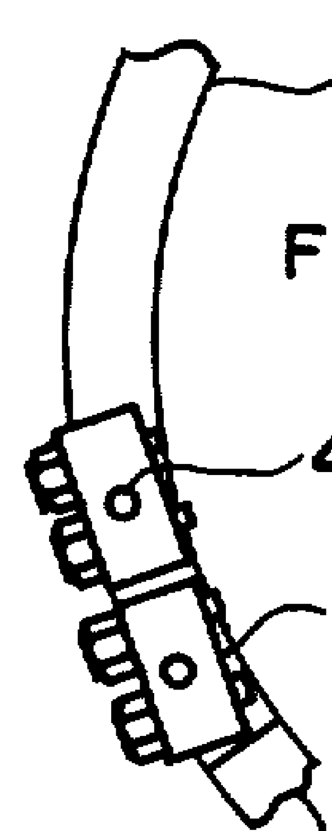

FIG. 26

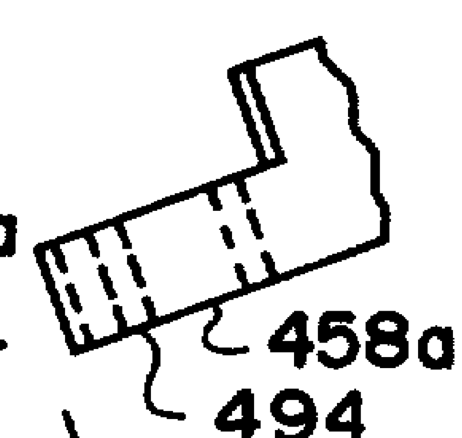

FIG. 25

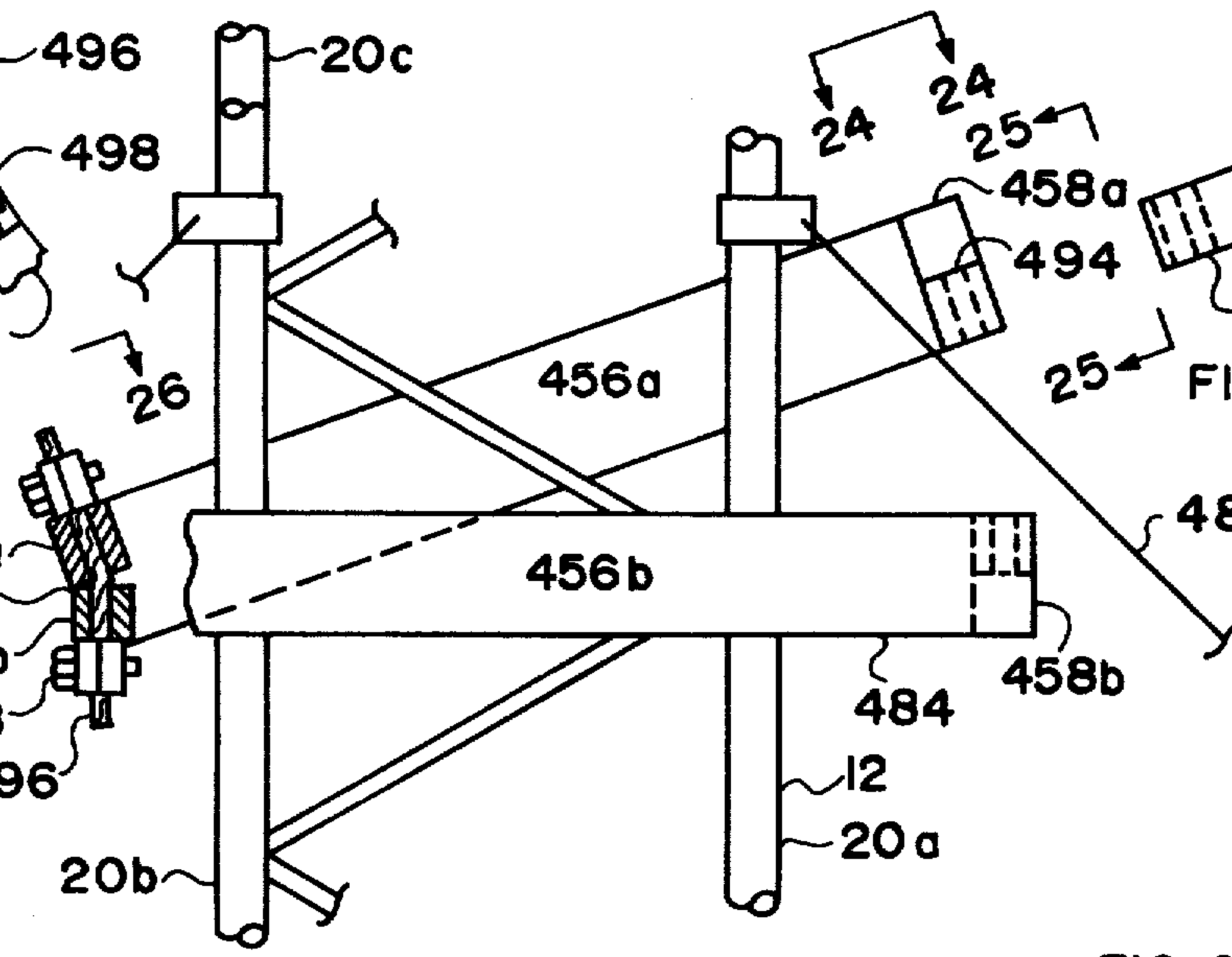

FIG. 23

ANTENNA TOWER ASSEMBLY AND METHOD OF ATTACHING ANTENNAS

The present invention relates generally to antenna tower assemblies, and more particularly to apparatus and methods for mounting and rotating a plurality of vertically-spaced antennas on a single antenna tower.

BACKGROUND ART

It is common practice to mount a plurality of separate antennas, which may include both receiving and transmitting antennas, on a single antenna tower. Further, it is traditional practice to mount one of the antennas on the top of the antenna tower and to rotate the one antenna by means of an electric motor and gear reducer. The remainder of the antennas are then mounted to the face of the antenna tower at various heights thereto. Thus only one antenna, that is, the antenna which is mounted to the top of the tower, is rotatable, and the remainder of the antennas are fixedly secured to the antenna tower.

Alternately, several antennas are mounted to one antenna rotator on the top of the antenna tower. This method of mounting has the disadvantage that all antennas must be rotated together, thus greatly diminishing the usefulness of the various antennas. Also, this method of mounting is limited in the type and number of antennas that can be rotated because of structural limitations.

When it has been desirable, or necessary, to rotate one of the face-mounted antennas, it has been customary to attach this antenna to the antenna tower by means of an outrigger, or side arm, that extends longitudinally out from the antenna tower. When the antenna tower consists of three vertically-disposed tower legs and truss bracing, it has been customary to construct this side arm from a section of the tower material.

This face-mounted antenna is then mounted at the outer end of the side arm by means of a second electric motor and gear reducer. This type of mounting for a rotatable antenna is highly unsatisfactory because of the effect of the metal in the antenna tower. That is, when this face-mounted and rotatable antenna is directed so that the antenna tower is directly behind the antenna, the antenna may be tuned for high performance. However, as the antenna is rotated to an angle where the antenna tower is to one side or the other of the antenna, the tuning of the antenna will be adversely affected. Further, as the antenna is rotated farther, not only will the tuning of the antenna further deteriorate, but also, the direction-sensing ability of the antenna will be adversely affected. That is, if this rotatable antenna is used as a search antenna, false directional readings will be indicated. Then, as the antenna is rotated to face the antenna tower, its tuning will be degraded even more, making the antenna highly ineffective either for transmission or receiving of radio frequencies.

Alternately, face-mounted antennas have been rotated by rotating the entire antenna tower. Of course, this requires an extremely large, heavy, and costly mechanism, is practical only for relatively short antenna towers of the non-guy-wired type, and has the additional disadvantage that all antennas are rotated simultaneously.

Kulikowski, in U.S. Pat. No. 2,623,999, shows an antenna that is mounted to a sleeve which is disposed coaxially around an antenna tower of the tubular mast type, and that is rotated by an electric drive motor. Kulikowski teaches a method of conductance coupling of the antenna to the lead-in conductors; but he does not address the technical problems of providing a workable rotating mount for face-mounting antennas to an antenna tower.

In particular, Kulikowski does not show, disclose, claim, or even intimate the need for, nor solutions for: vertically supporting the antenna, radially guiding the antenna, guiding against sideward tipping of the antenna-mounting ring, counterbalancing of torsional wind loads, use with towers of the trussed tower-leg type rather than the tubular mast type, electrical heating to overcome icing problems, or means for partially assembling the rotating device at ground level and then moving up past guy wires, all of which are advancements of the present invention.

DISCLOSURE OF INVENTION

In accordance with the broader aspects of this invention, there is provided an antenna tower assembly for the mounting and separately rotating of a plurality of vertically-disposed antennas on a single antenna tower.

In a preferred configuration, a single, two-piece antenna-mounting ring is mounted coaxially around an antenna tower of the type having three vertically-disposed tower legs. This antenna-mounting ring includes a V-shaped groove that is circumferentially disposed in an inner circumferential surface of the antenna-mounting ring.

Three support rollers, having vertically-disposed roller shafts, cooperate with upper and lower surfaces of the V-shaped groove in the antenna-mounting ring to rotatably support the antenna-mounting ring. Two of these support rollers are mounted to respective ones of two of the vertically-disposed tower legs by means of a support-roller assembly. A third one of the support rollers is mounted to the third of the tower legs by means of a support and drive assembly that includes an electric motor and gear reduction unit.

Preferably, the antenna-mounting ring includes a plurality of circumferentially-spaced gear teeth; and the roller shaft of the third support roller includes a drive pinion which meshes with the circumferentially-spaced teeth in the antenna-mounting ring and which is driven by the gear reduction unit.

In a second preferred embodiment, the roller shafts of the three support rollers are horizontally disposed; and the support rollers are frustoconical in shape. In this embodiment, the frustoconical support rollers engage a groove that is circumferentially disposed in the inner surface of the antenna-mounting ring. The antenna-mounting ring is rotated by a drive pinion whose shaft is horizontally disposed below one of the roller shafts and which engages circumferentially-spaced gear teeth on the antenna-mounting ring. These circumferentially-spaced gear teeth are disposed separate from and below the circumferential groove in the antenna-mounting ring.

In a third preferred embodiment, a tower-attaching ring circumscribes the three tower legs and is securely attached thereto. An antenna-mounting ring is coaxial to and circumscribes the tower-attaching ring. The antenna-mounting ring is rotatably mounted to, and supported by, the tower-attaching ring by means of a plurality of support rollers which are rotatably mounted to the antenna-mounting ring and which engage a groove that is circumferentially disposed in the outer surface of the tower-attaching ring. The support rollers are mounted for rotation about horizontal axes that are radially disposed with respect to a vertical axis of the antenna tower.

An electric drive motor and gear reduction unit are mounted to, and rotate with, the antenna-mounting ring. This electric drive motor and gear reduction unit rotate a drive pinion which is mounted for rotation about an axis that is both horizontal and radially disposed with respect to a vertical tower axis. The tower-attaching ring includes a plurality of circumferentially-spaced teeth which mesh with the teeth of the drive pinion.

In a fourth preferred embodiment, a first arcuately-shaped mounting portion is secured to the three tower legs, a second arcuately-shaped mounting portion is secured to the three tower legs at a vertically-spaced distance from the first arcuately-shaped mounting portion, and the mounting bracket for the antenna attaches to and slides circumferentially around the two arcuately-shaped mounting portions. Rotational positioning of the antenna of this fourth embodiment is by means of manually-turned screws.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic top view of a variation of the preferred embodiment of FIGS. 2-6;

FIG. 2 is a side elevation, taken substantially as shown by view line 2—2 of FIG. 1, showing the construction of the preferred embodiment wherein the antenna is manually rotated and then locked at a desired rotational position;

FIG. 3 is a cross-sectional view, taken substantially as shown by section line 3—3 of FIG. 2, showing construction of the attaching bracket;

FIG. 4 is an enlarged detail drawing of the guide plate of FIGS. 2 and 5, taken as shown in FIG. 2;

FIG. 5 is a top plan view of the preferred embodiment of FIG. 2;

FIG. 6 is a partial side view, taken substantially as shown by view line 6—6 of FIG. 5;

FIG. 7 is a schematic drawing of a direction-indicating device for the embodiments of the succeeding figures;

FIG. 8 is a top plan view of a preferred embodiment in which the roller shafts for the support rollers are vertically disposed;

FIG. 9 is a cross-sectional view, taken substantially as shown by section line 9—9 of FIG. 8, showing in reduced scale, the counterweight and wind-vane assembly;

FIG. 10 is a partial side elevation, taken substantially as shown by view line 10—10 of FIG. 8, showing a support roller assembly;

FIG. 11 is a cross-sectional view, taken substantially as shown by section line 11—11 of FIG. 8, showing the support and drive assembly;

FIG. 12 is a cross-sectional view, taken substantially as shown by section line 12—12 of FIG. 8, showing a modification of the support roller assembly wherein the support roller is resiliently urged into contact with the antenna-mounting ring by a spring;

FIG. 13 is an enlarged and partial view of a support roller, taken substantially as shown in FIG. 12, showing a resilient drive surface which may be used in place of the drive pinion of FIG. 11;

FIG. 14 is a cross-sectional view of an embodiment in which a support and drive assembly is secured to one of the tower legs, the support roller thereof rotates about a horizontally and radially-disposed axis, and the electric drive motor is fixedly secured with respect to the antenna tower;

FIG. 15 is a cross-sectional view of a support roller assembly for the embodiment of FIG. 14;

FIG. 16 is an enlarged and cross-sectional view of the support roller and bearing assembly for the embodiment of FIGS. 14 and 15 and for the embodiment of FIGS. 17-20;

FIG. 17 is a cross-sectional view taken substantially as shown by section line 17—17 of FIG. 19, showing a support roller assembly for the embodiment of FIGS. 17-20 that utilizes two circumferentially-disposed rings;

FIG. 18 is a cross-sectional view, taken substantially as shown by section line 18—18 of FIG. 19, showing the support and drive assembly for the embodiment of FIGS. 17-20 that utilizes two circumferentially-disposed rings;

FIG. 19 is a top view of the embodiment that utilizes two circumferentially-disposed rings;

FIG. 20 is a side elevation of the embodiment that utilizes two circumferentially-disposed rings, taken substantially as shown by view line 20—20 of FIG. 19;

FIG. 21 is a partial side elevation, taken substantially the same as FIG. 20, but showing only the tower-attaching ring and the screen grid that is optional for use as a reflecting device between the tower-attaching ring and the antenna tower;

FIG. 22 is a partial top view of an antenna tower assembly similar to that of FIG. 19, but illustrating a modification thereof for use with large Yagi antennas;

FIG. 23 is a partial side elevation showing the method of moving tower-attaching rings and antenna-mounting rings above guy wires;

FIG. 24 is a partial top view, taken substantially as shown by view line 24—24 of FIG. 23;

FIG. 25 is a partial side view, taken substantially as shown by view line 25—25 of FIG. 23; and

FIG. 26 is a partial top view, taken substantially as shown by view line 26—26 of FIG. 23.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to the drawings, and more particularly to FIG. 1, an antenna tower assembly **10** includes an antenna tower **12**, an arcuately-shaped first mounting portion or arcuate segment **14** having ends **13a** and **13b** and having arcuate surfaces **15a** and **15b** that are intermediate of the ends **13a** and **13b**, a second mounting portion **16**, and an antenna **18**.

The antenna tower **12** includes vertically-disposed tower legs, **20a**, **20b**, and **20c**, which are interconnected by truss bracing **22**. The arcuately-shaped first mounting portion **14** is disposed radially outside the tower leg **20a** and is disposed radially inside the tower legs **20b** and **20c**; so that a vertical axis **24** of the mounting portion **14** is disposed radially inside the antenna tower **12** but is disposed horizontally from a neutral axis **26** of the antenna tower **12**.

The arcuately-shaped first mounting portion **14** is attached to the tower legs **20a**, **20b**, and **20c** by respective ones of mounting brackets **28a**-**28c**.

The antenna tower assembly **10** further includes wind-resisting members or wind vanes **30a** and **30b** which function to provide torsional wind-balance means. When wind impinges against the antenna **18** from any angle, a force is produced. This force is indicated by a force vector **32**. In the FIG. 1 illustration, the force vector 32 causes a clockwise torque to be applied to the tower 12 that is the product of the force vector 32 and a moment arm 34 which is the orthogonal distance from the force vector 32 to the neutral axis 26 of the tower 12.

Wind impinging upon the wind-resisting member 30*b* produces a force as indicated by a force vector 36, producing a counterclockwise torque that is the product of the force vector 36 and a moment arm 38 which is the orthogonal distance from the force vector 36 to the neutral axis 26 of the tower 12. Thus the size of the wind-resisting member 30*b* can be selected, and/or the moment arm 38 can be changed, to provide effective torque balance for any size or type of antenna.

In like manner, with wind impinging upon the antenna 18 at various other angles, both of the wind-resisting members, 30*a* and 30*b*, provide torque-balancing forces.

Referring now to FIGS. 2–6, an antenna tower assembly 40 includes an antenna tower 12 having vertically-disposed tower legs 20*a*–20*c* and truss bracing 22, an arcuately-shaped first mounting portion or arcuate segment 42*a* that is disposed radially outside the tower legs 20*a*–20*c* and that is attached to the tower legs 20*a*–20*c* by respective ones of attaching brackets 44*a*–44*c*, an arcuately-shaped second mounting portion 42*b* that is similarly disposed with respect to the tower legs 20*a*–20*c* and that is similarly attached thereto, a third mounting portion 46 which includes an antenna mounting bracket 48 and guide or clamp plates 50, and an antenna 18 that is operatively secured to the mounting bracket 48 by bolts 49, and adjusting bracket assemblies 52*a* and 52*b*.

Each of the attaching brackets, such as the attaching bracket 44*a* of FIGS. 2 and 3, includes an inner portion 54 having a cylindrical surface 56 and an outer portion 58 having a cylindrical surface 60. The cylindrical surfaces 56 and 60 are sized to fit the tower leg 20*a*; and the portions 54 and 58 are secured to the tower leg 20*a* by bolts 62 and nuts 64 which are disposed in holes 66 and 68.

The outer portion 56 of the attaching bracket 44*a* includes elongated holes 70 which are positioned to cooperate with holes 72 in the mounting portions, 42*a* and 42*b*, and bolts 74 and nuts 76 are used to secure the mounting portions 42*a* and 42*b* to respective ones of the attaching brackets, 44*a*–44*c*.

The first and second mounting portions, 42*a* and 42*b*, are rolled from channel iron; and so the first and second mounting portions, 42*a* and 42*b*, each include a web 78 and arcuately-shaped flanges 80*a* and 80*b*. The arcuately-shaped flange 80*a* includes an arcuately-shaped outer surface 82*a* and an arcuately-shaped inner surface 82*b*.

Referring now to FIG. 4, the guide or clamp plates 50 each include a hole 84, a beveled surface 86 that conforms to the arcuately-shaped inner surfaces 82*b* of the mounting portions 42*a* and 42*b*, a relieved surface 88, and a pivot lug 90. Bolts 92 and nuts 94 are used to secure the guide or clamp plates 50 to the antenna mounting bracket 48.

To allow the antenna 18 to be rotationally positioned, the nuts 94 are loosened, allowing the bracket 48 and the guide or clamp plates 50 to slide with respect to the arcuately-shaped first and second mounting portions, 42*a* and 42*b*. The nuts 94 are tightened after radially positioning the antenna 18, thereby locking the antenna 18 in a selected rotational position by forcing the beveled surface 86 of the guide or clamp plate 50 into contact with the arcuately-shaped inner surface 82*b*.

Referring now to FIGS. 5 and 6, the adjusting bracket assemblies 52*a* and 52*b* are identical except for being mirror images of each other; so a description of one will suffice for both. The adjusting bracket assembly 52*a* includes an adjusting bracket 96*a* having a threaded boss 98*a*, an adjusting screw 100*a* that is threaded through the boss 98*a*, a clamp plate 102 that is similar to the clamp plate 50, and bolts 104 and nuts 106.

Referring now to FIGS. 2 and 5, the method of rotationally positioning the antenna 18 includes loosening the nuts 94, tightening the nuts 106, manually turning an adjusting screw, 100*a* or 100*b*, and tightening the nuts 94. Optionally, or alternately, the antenna 18 may be securely locked in a desired rotational position by forcing both the adjusting screws 100*a* and 100*b* against the antenna-mounting bracket 48.

Referring now to FIG. 7, each of the antenna tower assemblies that will be subsequently described includes a position indicator 120. The position indicator 120 includes a regulated power supply 122 having output terminals 124*a* and 124*b*, a potentiometer 126 having legs 128*a* and 128*b* that are connected respectively to the output terminals 124*a* and 124*b* and having an arm 130, and an electrical meter 132 that is connected to the leg 128*a* and to the arm 130 of the potentiometer 126. The potentiometer 126 schematically represents a ten-turn potentiometer, such as is common in the electronics industry.

The use of a ten-turn potentiometer, and an electrical circuit, such as is shown in FIG. 7, to indicate the rotational position of an antenna, is common to the art.

Referring now to FIGS. 8 and 12, an antenna tower assembly 140 comprises an antenna tower 12 having vertically-disposed tower legs, 20*a*–20*c*, and truss bracing 22. The antenna tower assembly 140 further comprises an antenna-mounting ring 142 having an antenna-attaching lug 144, a counterbalance and wind vane attaching lug 146, a circumferential inner surface or circumferential ring surface 148, a V-shaped circumferential groove 150 that includes an upper groove surface or upper circumferential surface 152, and a lower groove surface or lower circumferential surface 154, a relief groove 156, and a plurality of circumferentially-spaced gear teeth 158.

The antenna-mounting ring 142 is supportingly, guidingly, and rotatably attached to the antenna tower 12 by three support rollers such as a support roller 160 of FIGS. 8, 10, and 12.

Referring now to FIG. 10, the support roller 160 includes a wedge-shaped circumferential surface 162 having an upper circumferential support surface 164 that supportingly engages the upper groove surface 152, and having a lower circumferential guide surface 166 that cooperates with the lower groove surface 154 to prevent tilting of the antenna-mounting ring 142.

Referring now to FIGS. 8 and 10, a support roller assembly 168 includes a support housing 170 having a bell-shaped shield 172, a mounting arm 174 having a cylindrical recess 176 therein, and threaded holes 180. The support roller 160 includes a roller shaft 182 which is secured in the housing 170 by longitudinally-spaced ball bearings 184.

Referring now to FIG. 13, in an optical configuration, a support roller 186 includes roller shaft 188. The support roller 186 also includes a roller body 190 which is preferably fabricated from steel, and a resilient cover

192 of molded rubber. Thus, the support roller 186 includes a resilient upper or support surface 194 and a resilient lower or guide surface 196.

Referring again to FIGS. 8 and 10, one of the support roller assemblies 168 is attached to the tower leg 20a by a bracket 198 and by bolts 200 that threadably engage the threaded holes 180. A support roller assembly, not shown, which is identical to the support roller assembly 168, is attached to the tower leg 20b, the support roller 160 thereof being illustrated.

Referring now to FIGS. 8 and 11, a support and drive assembly 202 includes a support housing 204 having a mounting arm 206 with a cylindrical recess 208 therein, having an adjusting lug 210, and having a shield portion 212.

The support and drive assembly 202 includes an electric drive motor and gear reducer unit 214 that is attached to a surface 216 of the housing 204 and that is attached to a roller shaft 218. The roller shaft 218 projects through the housing 204.

The support and drive assembly 202 also includes a support roller 219 which is identical to the support roller 160 of FIG. 12 except that the support roller 219 includes the roller shaft 218; and so the support roller 219 includes all of the surfaces as previously described for the support roller 160.

The support and drive assembly 202 also includes a toothed drive pinion 220 that is coaxially attached to the roller shaft 218 and that includes gear teeth 222 which progressively mesh with the gear teeth 158 of the antenna-mounting ring 142.

Finally, the support and drive assembly includes a ten-turn potentiometer 224 that is driven by the electric motor and gear reducer unit 214. The potentiometer 224 and the connection thereof to the electric drive motor and gear reducer unit 214 are conventional and do not comprise an inventive part of the present invention.

Referring now to FIG. 8, the support roller assembly 168 may be rotationally positioned about the tower leg 20a by loosening the bolts 200 and a bolt 226 that attaches an adjusting lug 228 of the housing 170 to a spider plate 230. The spider plate 230 includes three legs 232, each of which includes an elongated adjusting hole 234. In like manner, the support and drive assembly 202 may be rotationally positioned about the tower leg 20c by loosening the bolts 200 and the bolt 226.

Referring again to FIGS. 8 and 10–12, when any one of the support rollers 160 or 219 is rotationally positioned about the respective one of the tower legs, 20a–20c, providing close proximity between all the guide surfaces 166 of the support rollers 160 or 219 and the lower groove surface 154 of the antenna-mounting ring 142, the gear teeth 222 of the drive pinion 220 engage the gear teeth 158 of the antenna-mounting ring 142 with proper backlash.

Referring now to FIGS. 8, 12, and 13, alternately, the spider plate 230 may be modified to provide one leg 236 that includes a spring tension device 238. The spring tension device 238 includes a cylindrical rod 240, a collar 242 which is attached to the rod 240 by a transverse pin 244, and a spring 246. The rod 240 is inserted through a hole 248 in a lug 250 and through a hole 252 in a lug 254, the lug 250 being welded to the leg 236 as shown and the lug 254 being integral with the leg 236. In this modification, the bolts 200 are left slightly loose or shims, not shown, are placed between the bracket 198 and the arm 174 so that the bolts 200 can be tightened without the cylindrical recess 176 being tightened against the tower leg 20a. Therefore, rather than the spider plate 230 being attached to the housing 170 by the lug 228, the rod 240 presses against the housing 170 and resiliently urges the housing 170 to rotate outwardly about the antenna tower leg 20a, thereby resiliently urging the support roller 160 thereof into resilient engagement with both the upper groove surface 152 and the lower groove surface 154 of the V-shaped groove 150. In this adaptation, preferably, the toothed drive pinion 220 and the circumferentially-spaced gear teeth 158 are deleted and the support roller 186, with the resilient surfaces 194 and 196, is used to drive the antenna-mounting ring 142 by friction engagement of the resilient surfaces 194 and 196 with respective ones of the groove surfaces 152 and 154.

Referring now to FIGS. 8 and 9, an antenna 256 that includes an attaching lug 258 is attached to the lug 144 of the antenna-mounting ring 142 by bolts 260. In like manner, a counterbalance and wind vane assembly 262 is attached to the lug 146 by bolts 264. The counterbalance and wind vane assembly 262 includes a housing 266, a wind vane or wind-resisting member 268, and a counterbalance weight 270 that is retainably inserted into the housing 266. The wind-resisting member 268 is sized and proportioned to provide a wind-resisting force and torque balance to match and counteract the wind-resisting force and torque applied to the antenna tower 12 by the antenna 256 in the same manner as described in conjunction with FIG. 1; and the counterbalance weight 270 is sized to effectively counterbalance torque that is applied to the antenna-mounting ring 142 by the antenna 256. That is, the product of the weight of the counterbalance weight 270 times a distance 272 from a neutral axis 26 of antenna tower 12 to a centroid 274 of the weight 270 is adjusted to substantially equal the weight of the antenna 256 times the distance (not shown) from the neutral axis 26 of the antenna tower 12 to the centroid (not shown) of the weight of the antenna 256.

Referring now to FIGS. 14 and 15, an antenna tower assembly 290 includes an antenna tower 12 having vertically-disposed tower legs 20a and 20b and a third vertically-disposed tower leg (not shown), an antenna-mounting ring 292 that is circumferentially disposed around the antenna tower 12, a support roller assembly 294 that is attached to the tower leg 20a, a support and drive assembly 296 that is attached to the tower leg 20b, and a second support roller assembly (not shown) that is identical to the support roller assembly 294 and that is attached to a third tower leg (not shown).

The antenna-mounting ring 292 includes a V-shaped groove 298 that is circumferentially disposed in a circumferential inner surface or circumferential ring surface 300 of the antenna-mounting ring 292. The groove 298 includes an upper groove surface or upper circumferential surface 302, and a lower groove surface or lower circumferential surface 304.

Referring now to FIGS. 14 and 16, and more particularly to FIG. 16, a roller and bearing assembly 306 includes a support roller 308, a roller shaft 310, and a plurality of circumferentially-disposed steel balls 312. The roller shaft 310 includes an enlarged portion 314 having a frustoconical surface 316 and a circumferential ball groove 318 that is disposed in the surface 316. The support roller 308 includes a frustoconical outer surface 320, a bore 322 having a frustoconical inner surface 324, and a circumferentially-disposed ball groove 326 in the inner surface 324. The balls 312 are circumferentially disposed in the grooves **318** and **326**, thereby providing an integral ball bearing beteen the support roller **308** and the roller shaft **310**.

The roller shaft **310** is attached to a support housing **328** of the support and drive assembly **296** by inserting the roller shaft **310** into a bore **330** of the housing **328**.

Referring now to FIG. **15**, the support roller assembly **294** includes a roller and bearing assembly **332** that is identical with the roller and bearing assembly **306** except that the roller and bearing assembly **332** includes a longer roller shaft **334** and an integral adjusting screw **336** with a threaded portion **338**.

The roller shaft **334** is slidably and rotatably received into a bore **340** of a support housing **342** of the support roller assembly **294**; and the threaded portion **338** is threadingly received into a threaded bore **344** of the housing **342**. Thus rotation of the adjusting screw **336** is effective to radially adjust the support roller **308**; and radial adjustment of the support roller **308** is effective to control a clearance **346** between the support roller **308** and the lower or guide surface **304** of the antenna-mounting ring **292**.

The housing **342** of the support roller assembly **294** includes an upper housing portion **348** and a lower housing portion **350** which are interconnected by any suitable means.

The support roller assembly **294** is attached to the tower leg **20***a* of the antenna tower **12** by brackets **352** and bolts **354**.

The housing **328** of the support and drive assembly **296** includes an upper housing portion **356** and a lower housing portion **358** that are interconnected by any suitable means. An electric drive motor **360** having an output shaft **362** is mounted in the lower housing portion **358**. A gear reducer unit **364** is mounted in the lower housing portion **358**, is attached to the output shaft **362** of the electric drive motor **360** and includes an output shaft **366**. Also a ten-turn potentiometer **368** is mounted in the lower housing portion **358** and is connected to and driven by the gear reducer unit **364**.

The antenna-mounting ring **292** includes a plurality of circumferentially-spaced gear teeth **370**; and the support and drive assembly **296** includes a bevel gear or toothed drive pinion **372** being coaxially mounted onto the output shaft **366** and having gear teeth **374** that progressively mesh with the gear teeth **370** as the drive pinion **372** is rotated by the electric drive motor **360** and rotates the antenna-mounting ring **292**.

The support and drive assembly **296** is attached to the tower leg **20***b* by brackets **352** and bolts **354**.

Referring again to FIGS. **14** and **15**, an electrical resistance heating unit **376** which includes an electrical resistance unit **378** and a molded body **380** of dielectric material is circumferentially disposed around the antenna-mounting ring **292** and is attached thereto by screws **382**. The antenna tower assembly **290** further includes an antenna **384** that is attached to the antenna-mounting ring **292** by a housing **386**.

Referring now to FIGS. **8**, **9**, **14**, and **15**, preferably, a counterbalance weight, such as the counterbalance weight **270** of FIG. **9** and a wind-resisting member such as the wind vane **268** of FIG. **9** are attached to the antenna-mounting ring **292** at a point circumferentially spaced from the housing **386**. The counterbalance and wind vane assembly **262** of FIGS. **8** and **9** may be attached to the antenna-mounting ring **292** of FIGS. **14** and **15** in the same manner as is shown for attaching the counterbalance and wind vane assembly **262** to the antenna-mounting ring **142** of FIGS. **8** and **9**, or by the use of an additional housing identical to the housing **386**. The detailed construction of the counterbalance and wind vane does not form an inventive part of the present invention.

In summary, the embodiment of FIGS. **14** and **15** differs from the embodiment of FIGS. **8–13** in that the roller shafts **310** and **334** of FIGS. **14** and **15** are horizontally disposed whereas the roller shafts **182** and **218** of FIGS. **10** and **11** are vertically disposed. The embodiment of FIGS. **14** and **15** also varies from the embodiment of FIGS. **8–13** in that the clearance **346** between the support rollers **308** and the lower surface **304** of the V-shaped groove **302** is by means of the adjusting screw **336** whereas clearance between the rollers **166** and **219** and the lower surface **154** of the groove **150** of the embodiment of FIGS. **8–13** is by means of rotationally positioning the support roller assembly **168** or the support and drive assembly **202** about one of the tower legs, **20***a* or **20***c*.

Similarities between the embodiment of FIGS. **14** and **15** and the embodiment of FIGS. **8–13** include the mounting of three support rollers to respective ones of three antenna tower legs and both supporting and guiding an antenna-mounting ring by engagement of support and guide surfaces of support rollers with support and guide surfaces of a groove that is circumferentially disposed in the antenna-mounting ring.

Referring now to FIGS. **17–20**, an antenna tower assembly **400** includes an antenna tower **12** having a plurality of vertically-disposed tower legs **20***a*–**20***c*, a tower-attaching ring **402** being attached to the antenna tower **12** by brackets **404**, an antenna-mounting ring **406** being circumferentially disposed about the tower-attaching ring **402**, a support and drive assembly **408** being attached to the antenna-mounting ring **406** by bolts **410**, an antenna **412**, a support and counterbalance assembly **414** being attached to the antenna-mounting ring **406**, a wind vane **416** being attached to the support and counterbalance assembly **414** and support roller assemblies **306** that are attached to the antenna-mounting ring **406** by means which will be subsequently described.

Referring now to FIG. **18**, the support and drive assembly **408** includes a housing **418** having an upper housing portion **420** and a lower housing portion **422**, a support roller assembly **306** which was previously discussed in conjunction with FIG. **16**, and whose shaft, **310**, is horizontally disposed in a bore **424** in the upper housing portion **420**, an electric drive motor **360** having an output shaft **362**, a gear reducer unit **364** being driven by the output shaft **362** of the electric drive motor **360** and having an output shaft **366**, a potentiometer **368** that is attached to the gear reducer unit **364** by a shaft **426**, and a bevel gear or drive pinion **372** which includes circumferentially-spaced gear teeth **374** and which is attached to the output shaft **366**.

The tower-attaching ring **402** includes a circumferential outer surface or circumferential ring surface **428** and a circumferentially disposed V-groove **430** in the circumferential outer surface **428**. The groove **430** includes a lower circumferential surface or lower groove surface **432**, and an upper circumferential surface or upper groove surface **434**. The support roller **308** supportingly engages the support surface **434** of the tower-attaching ring **402**.

The tower-attaching ring **402** also includes a plurality of circumferentially-spaced gear teeth **436**. The gear teeth 374 of the drive pinion 372 selectively engage the gear teeth 436 as the electric drive motor 360 rotates the output shaft 366 through the gear reducer unit 364.

The antenna 412 is attached to the support and drive assembly 408 by clamping the antenna 412 between the housing portions 420 and 422 of the housing 418.

Referring now to FIG. 17, the support and counterbalance assembly 414 includes a housing 418 having an upper housing portion 420 and a lower housing portion 422, a support roller assembly 306 which is retainingly inserted into a bore 424 of the top housing portion, and a counterbalance weight 438 which has been placed in a cavity 440 of the housing 418. The wind vane 416 is attached to the assembly 414 by clamping the wind vane 416 between the housing portions 420 and 422 of the housing 418.

An electrical resistance heating unit 442 includes an electrical resistance unit 444 that is molded in a dielectric body 446 and that is attached to the tower-attaching ring 402 by screws 448.

Referring now to FIGS. 19 and 20, the tower-attaching ring 402 is attached to the antenna tower 12 by the brackets 404; and the antenna-mounting ring 406 is attached to the tower-attaching ring 402 by four roller and bearing assemblies 306. One roller and bearing assembly 306 is a part of the support and drive assembly 408, a second one of the roller and bearing assemblies 306 is a part of the support and counterbalance assembly 414, and the other two of the roller and bearing assemblies 306 are a part of support roller assemblies 450*a* and 450*b*.

The support roller assemblies 450*a* and 450*b* are constructed the same as the support and counterbalance assembly 414 of FIG. 17 except that the counterbalance weight 438 is deleted, the wind vane 416 is deleted, and housings 452 of the assemblies 450*a* and 450*b* are shortened, as shown in FIG. 19, from the housing 418 of FIG. 17.

In summary, the embodiment of FIGS. 17–20 varies from the embodiment of FIGS. 14 and 15 in that the embodiment of FIGS. 17–20 includes two rings, 402 and 406, that are coaxially disposed, the tower-attaching ring 402 being attached to the antenna tower 12, and the antenna-mounting ring 406 being supportably and rotatably attached to the tower-attaching ring 402 by the roller and bearing assemblies 306. The embodiment of FIGS. 17–20 also differs from the embodiment of FIGS. 14 and 15 in that the electric drive motor 360 of FIGS. 17–20 rotates about the antenna tower 12; whereas the electric drive motor 360 of FIGS. 14 and 15 is stationary with respect to the antenna tower 12.

Referring now to FIGS. 19–21, and more particularly to FIG. 21, optionally, a cylindrically-shaped grid or reflecting device 454, is radially interposed between the antenna tower 12 and the tower-attaching ring 402, and is electrically bonded to the antenna tower 12. The purpose of the reflecting device 454 is to provide a reflecting surface that is uniform in size and is constant in distance from the antenna 412 to the antenna tower 12. As shown in FIG. 19, an element 455 of the antenna 412 remains at a constant distance from the reflecting device as the antenna 412 is rotated. Without the reflecting device 454, both the area of the reflecting surface, and the distance to the reflecting surface from the antenna 412 to the metal of the antenna tower 12 will vary slightly, depending upon the rotational position of the antenna tower 12 with respect to various ones of the tower legs, 20*a*–20*c*, and the strut bracing 22.

Referring again to FIG. 21, the tower-attaching ring 402 includes arcuate segments 456*a* and 456*b*. The arcuate segments 456*a* and 456*b* are identical and each includes a lapped-joint end 458*a* and 458*b*.

Referring now to FIG. 22, an antenna tower assembly 470 includes an antenna tower 12 having vertically-disposed tower legs 20*a*–20*c*, and a tower-attaching ring 402 that is attached to respective ones of the antenna tower legs 20*a*–20*c* by brackets 404. An antenna-mounting ring 472 is supportingly and rotatably attached to the tower-attaching ring 402 by antenna-attaching and support roller assemblies 474*a* and 474*b*, the support and drive assembly 408 of FIG. 18, two support and counterbalance assemblies 414 of FIG. 17, and a support roller assembly 450*a*. The support roller assembly 450*a* was described in conjunction with FIG. 19.

The antenna-attaching and support roller assemblies 474*a* and 474*b* each include one of the roller and bearing assemblies 306 and each is constructed substantially the same as the assembly 414 of FIG. 17. Thus it can be seen that the embodiment of FIG. 22 varies from the embodiment of FIGS. 17–20 only in that a Yagi antenna 476 is mounted to both of the assemblies 474*a* and 474*b* rather than being mounted to a single assembly, such as the assembly 408 of FIG. 18. Thus, a total of six assemblies, each having a roller and bearing assembly 306, are used to give greater support for large antennas, such as the Yagi antenna 476. Two support and counterbalance assemblies 414 are used to compensate for the extra size and weight of the Yagi antenna 476 over smaller antenna assemblies; and a wind vane 416 is attached to each of the assemblies 414 to compensate for the large size of the Yagi antenna 476.

Referring now to FIGS. 23–26, the method of assembly includes placing arcuate segments 456*a* and 456*b* around an antenna tower 12 that has vertically-disposed tower legs 20*a*–20*c*, connecting an end 482*a* of the segment 456*a* to an end 482*b* of the segment 456*b* to provide a tower-retaining or tower-retained ring 484 having unconnected lapped-joint ends 458*a* and 458*b*, moving the ring 484 up to guy wires 488, lifting the end 458*a* of the ring 484 above the end 458*b* of the ring 484 and above one of the guy wires 488 by rotating the segment 456*a* about a junction or connection 490 between the interconnected ends 482*a* and 482*b*, rotating the end 458*a* around the antenna tower 12, lifting the tower-retaining ring 484 to a desired height position as shown in FIG. 21, connecting the end 458*a* to the end 458*b* to make a complete ring 402 as shown in FIG. 21, and attaching the ring 402 to the antenna tower 12.

Referring again to FIGS. 23–26, the ends 458*a*, 458*b*, 482*a*, and 482*b*, are of the lapped end construction as shown and each includes two bolt holes 494. Two pieces of woven steel cable 496 and four cable clamps 498 are used to interconnect the ends 482*a* and 482*b* as shown in FIGS. 23 and 26, the cable clamps 498 being positioned on respective ones of the cables 496 to allow the end 458*a* to be lifted above the end 458*b*.

The use of the cables 496 through two of the holes 494 in the ends 482*a* and 482*b* is effective to prevent the ends 458*a* and 458*b* from being spaced-apart far enough for the ring 484 to be separated radially from the antenna tower 12. Therefore, the ring 484 is made to be tower-retaining by interconnecting the ends 482*a* and 482*b*.

In antenna tower assemblies of the type that utilize guy wires to achieve lateral stability of the antenna tower, it is sometimes necessary to disconnect one or more guy wires in order to raise the antenna and/or antenna-mounting parts upwardly past the guy wires.

In the present invention, a tower-attaching ring, an antenna-mounting ring, or any other ring or arcuate segment, may be built or assembled as a tower-retaining ring. Thus, whether the tower-retaining ring is a tower-attaching ring or an antenna-mounting ring, it is assembled to the tower **12**, at any convenient height position, by moving a first arcuate segment transversely toward the tower **12** and into an arcuate relationship with the tower **12**, by moving a second arcuate segment transversely toward the tower **12** and into tower-encircling relationship with the first arcuate segment, and by interconnecting ends of the arcuate segments.

The tower retaining ring, whether it be a tower-attaching ring or an antenna-mounting ring, may be raised above the guy wires by rotating one unconnected end above the guy wires. Thus the present invention obivates the danger of men working on a tower with one or more disconnected guy wires or the extra expense of temporarily attaching extra guy wires to provide lateral stability for the antenna tower while the permanent guy wires are disconnected.

The use of a tower-retaining ring also provides greater safety to the tower crew; because a tower-retaining ring, with any other equipment assembled thereto, may be pre-assembled at ground level and may be raised as a unit, being guidingly retained to the tower as the assembly is raised, as opposed to separately carrying many individual parts up the face of the tower and assembling them at the antenna-mounting height.

Referring now to FIGS. **8–13**, the method of rotatably mounting an antenna **256** to an antenna tower **12** having three vertically-disposed tower legs, **20*a*–20*c***, comprises attaching one of the support housings **170** to each of two of the tower legs, **20*a*** and **20*b***, attaching the support housing **204** to the tower leg **20*c***, placing the antenna-mounting ring **142** around the tower **12**, rotatably connecting the ring **142** to the support housing **170** and to the support housing **204** by attaching the support rollers **160** and **219** to the housings **170** and **204**, and attaching an antenna **256** to the ring **142**.

Referring now to FIGS. **14–20**, the method further includes electrically heating the antenna-mounting ring or second mounting portion **292** by the use of an electrical resistance heating unit **376**, or electrically heating the tower-attaching ring or first mounting portion **402** by the use of an electrical resistance heating unit **442**, and then rotationally positioning the antenna, **384** or **412**, by use of the electric drive motor **360**.

Referring now to FIGS. **1, 2, 8, 14–15, 17–20**, and **22**, if respective ones of the antennas **18, 256, 384, 412**, and **476**, and if respective ones of the antenna towers **12** are deleted from respective ones of the antenna tower assemblies **10, 40, 140, 290, 400**, and **470**, the respective antenna tower assemblies become rotationally positionable mounts **500, 502, 504, 506, 508**, and **510**, respectively.

Referring now to FIG. **8**, the antenna-mounting ring **142** includes first and second arcuate segments **512*a*** and **512*b***, each having first and second ends **514*a*** and **514*b***. The arcuate segments **512*a*** and **512*b*** are positioned around the antenna tower **12** with the first ends **514*a*** abutting the second ends **514*b***. The arcuate segments **512*a*** and **512*b*** may be interconnected by the attaching lug **258** and the bolts **260**, and by the bolts **264** attaching the housing **266** to both of the arcuate segments **512*a*** and **512*b***. However, the method and details of connection of the ends **514*a*** and **514*b*** of the segments **512*a*** and **512*b*** are not a part of the present invention.

Referring now to FIGS. **14** and **15**, the antenna-mounting ring **292** includes first and second arcuate segments **516*a*** and **516*b***, each having first and second ends **518*a*** and **518*b***. The arcuate segments **516*a*** and **516*b*** are positioned around the tower **12** with the first ends **518*a*** abutting the second ends **518*b***; and the arcuate segments **516*a*** and **516*b*** are interconnected by any suitable means. The detailed method of interconnecting the arcuate segments **518*a*** and **518*b*** is not a part of the present invention.

Referring now to FIG. **19**, the antenna-mounting ring **406** includes first and second arcuate segments **520*a*** and **520*b***, each having first and second ends **522*a*** and **522*b***. The arcuate segments **520*a*** and **520*b*** are positioned around the tower **12** with the first ends **522*a*** abutting the second ends **522*b***; and the arcuate segments **520*a*** and **520*b*** are interconnected by any suitable means.

Referring now to FIGS. **8, 11, 14**, and **16–18**, the arcuate segments **512*a*** and **512*b*** each include arcuate surfaces **524*a*** and **524*b***, the arcuate segments **516*a*** and **516*b*** each include arcuate surfaces **526*a*** and **526*b***, and the arcuate segments **456*a*** and **456*b*** each include arcuate surfaces **528*a*** and **528*b***.

The upper circumferential surfaces **152, 302**, and **434** each include one arcuate surface, **524*a*, 526*a***, or **528*a***, of both of the respective ones of the arcuate segments, **512*a*** and **512*b*, 516*a*** and **516*b***, or **456*a*** and **456*b***; and the lower circumferential surfaces **154, 304**, and **432** each include one arcuate surface, **524*b*, 526*b***, or **528*b***, of both of the respective ones of the arcuate segments **512*a*** and **512*b*, 516*a*** and **516*b***, or **456*a*** and **456*b***.

The arcuate segments **14, 42, 512*a*, 512*b*, 516*a*, 516*b*, 520*a*, 520*b*, 456*a***, and **456*b*** each include an opening, **530*a*** or **530*b***, that is disposed radially inward of an arcuate surface, **15*a*** or **15*b*, 82*a*** or **82*b*, 152** or **154, 302** or **304, 432** or **434**, and that opens outward between the ends **15*a*** and **15*b*, 514*a*** and **514*b*, 518*a*** and **518*b*, 522*a*** and **522*b*, 458*a*** and **458*b***, of respective ones of the arcuate segments.

Preferably, all of the segments and rings are disposed about a vertical axis or segment axis **26** that is parallel to the neutral axis **24** of the antenna tower; so all of the segments and rings are disposed in a plane **532** that is orthogonal to the neutral axis **24**; and so the circumferential surfaces **152, 154, 302, 304, 432**, and **434** are disposed circumferentially around the axis **26**. All of the rings **142, 292, 402**, and **406** include a tower-receiving or tower-accepting opening **548** that includes the openings **530*a*** and **530*b*** of the respective arcuate segments.

Referring now to FIGS. **5** and **8**, the antenna tower **12** includes three faces **534*a*–534*c*** which comprise a side of the tower **12** that is disposed between any adjacent two of the tower legs **20*a*–20*c***. Thus, in broadest terms, the rotationally positionable mounts **500, 502, 504, 506, 508**, and **510** are attached to a face **534*a*–534*c*** of the tower **12**, as opposed to being attached to a top (not shown) of the tower **12**.

In the embodiment of FIGS. **8–13**, the first mounting portion includes two of the support housings **170** and the support housing **204**; and the antenna-mounting ring **292** is the second mounting portion.

In like manner, in the embodiment of FIGS. **14–16**, the first mounting portion includes two of the support housings **342** and the support housing **328**.

In contrast, in the embodiments of FIGS. **16–21** and FIG. **22**, the antenna-attaching ring **402** is the first mounting poriton; and the second mounting portion includes the antenna-mounting ring **406** or the antenna-mounting ring **472**.

In the embodiment of FIGS. **8–13**, the first and second mounting portions are interconnected by attaching a support roller **166** to each of the support housings **170** and by attaching a support roller **219** to the support housing **204**.

In the embodiments of FIGS. **14–16**, FIGS. **16–21**, and FIG. **22**, the support rollers **306** are frustoconical in shape and include a large diameter end **460** that is adjacent to the roller shaft **310**, and a small diameter end **462**. In like manner, the drive pinion **372** includes a large diameter end **464** that is adjacent to the shaft **366**, and a small diameter end **466**.

Referring finally to FIGS. **2–5**, **8–13**, **14–16**, and **16–22**, if the antennas **18**, **256**, **384**, **412**, and **476** and the wind vanes **268** and **416** are deleted from the tower and rotationally positionable mount assemblies **40**, **140**, **290**, **400**, and **470**, then the assemblies become tower and rotationally positionable mount assemblies **536**, **538**, **540**, **542**, and **544**.

In summary, the present invention provides means for rotatably mounting one or more search devices to the face of a tower. The search devices which may be mounted include radio antennas, video cameras, and searchlights.

The present invention includes an embodiment wherein two vertically-spaced and arcuately-shaped rings are mounted to the three tower legs of the tower and the search device is supportingly guided on the arcuately-shaped rings.

The present invention includes two embodiments wherein a search-device mounting ring is rotatably attached to the three tower legs of the tower by a roller that is operatively attached to each tower leg and that engages a groove in the search-device mounting ring. In one of these embodiments, the roller shafts are vertically disposed and are both radially and circumferentially disposed about a vertical axis.

This vertical axis is preferably the neutral axis of the tower, but it may be any vertical axis that is disposed radially inside the tower legs and truss bracing of the tower.

In the other of these two embodiments, the roller shafts are disposed both orthogonally and radially with respect to a vertical axis.

The present invention includes a fourth embodiment wherein two rings are used. One ring is attached to the tower and the other ring is rotatably attached to the first ring by use of a plurality of rollers.

The present invention includes: roller and groove means for supporting, guiding, and stabilizing the search-device mounting ring, counterbalance means for counterbalancing the weight of a search device, torsional wind balance means for counteracting torsional wind loads that are applied to the tower by the search device, manual or electrical means for rotating the search device, means for locking the search device in a desired position, means for electrically heating and thus thawing ice from whichever ring includes gear teeth, a reflecting device that prevents an antenna from seeing a varying area of metal in the antenna tower as the antenna is rotated, apparatus and method for assembling the tower-attaching and antenna-mounting rings around the antenna tower at any convenient height, and a method for raising partially-assembled rings above guy wires.

The support rollers cooperate with a first circumferential surface to support a ring-shaped mounting portion, cooperate with a second circumferenial surface to vertically restrain the ring-shaped mounting portion and thereby to prevent tilting of the ring-shaped mounting portion, and cooperate with one of the mounting portions to radially guide the ring-shaped mounting portion, as shown in FIGS. **8**, **11**, **12**, **14**, **15**, and **17–19**.

The support rollers each include a roller shaft; and respective ones of the support rollers are supported, verticaly restrained, and radially restrained by operative attachment of the respective ones of the roller shafts to another mounting portion, as shown in the drawings.

The present invention provides apparatus and method for mounting a plurality of antennas, or search devices, to a single tower, and for separately rotating, or rotationally positioning, the antennas or search devices. Therefore, the present invention provides functional advantages over prior art systems wherein only one antenna can be rotated, and economic advantages over prior art systems wherein multiple towers are required.

Further, the present invention allows the use of larger antennas on a given size of tower, the use of a larger number of antenna on a given size of tower, or the use of a tower of smaller cross-sectional dimensions and less torsional rigidity for a given number of antennas of a given size; because all of the embodiments of the present invention apply torsional loads equally to all of the tower legs, and because of the torsional wind balance that is provided by the use of wind vanes,

While particular apparatus has been shown and described, the scope of the present invention is to be determined by the appended claims. Further, the parenthetical numbers that have been inserted into the claims are for illustrative purposes only; and the parenthetical numbers are not a part of the claims. Therefore, the parenthetical numbers in the claims are not to be considered as a limitation to the scope of any claim.

INDUSTRIAL APPLICABILITY

The present invention provides apparatus and methods for the rotatable mounting and both separate and selective rotational positioning of a plurality of antennas or search devices on a single tower.

The present invention may be used by homeowners for mounting and rotating of antennas of the types used for receiving video signals, for broadcasting and receiving of citizens band radio signals, and for receiving both AM and FM radio signals.

The present invention may be used by radio amateurs for both broadcasting and receiving antennas, by commercial radio stations, by microwave transmission companies, and by the military forces for radio communications.

In addition, the present invention may be used to mount and separately rotate such search devices as directional receiving antennas, video cameras, and searchlights in such numbers or combinations as are needed.

What is claimed is:

1. A tower and rotationally positionable mount assembly (**538**, **540**, **542**, or **544**) which comprises a tower (**12**) having a neutral axis (**26**);

a first mounting portion (**170**+**204** of FIG. **8**, **328**+**342** of FIGS. **14–15**, or **406** or **418** of FIG. **18**);

a first segment (512a, 516a, or 456a) having a first arcuate surface (524a, 524b, 526a, 526b, 528a, or 528b), and having a first opening (530a) that is disposed radially inward of said first arcuate surface and that opens radially outward from said first segment distal from said first arcuate surface;

a second segment (512b, 516b, or 456b) having a second arcuate surface (524a, 524b, 526a, 526b, 528a, or 528b), and having a second opening (530b) that is disposed radially inward of said second arcuate surface and that opens radially outward from said second segment distal from said second arcuate surface;

a second mounting portion (142 of FIG. 8, 292 of FIG. 14, or 402 of FIG. 18), being disposed circumferentially around said tower, and having a circumferential surface (152 or 154 of FIG. 12, 302 or 304 of FIGS. 14–15, or 432 or 434 of FIGS. 17–18) that includes both of said arcuate surfaces, that circumscribes said tower, and that is disposed around an axis (24) that is substantially parallel to said neutral axis;

securing means (174+206 of FIG. 8, 352+354 of FIG. 14, or 404 of FIG. 18) for operatively securing one (170+204 of FIG. 8, 328+342 of FIGS. 14–15, or 402 of FIGS. 17–18) of said mounting portions to said tower;

attaching means, comprising said circumferential surface, for supportingly attaching the other (142, 292, 406, or 418) of said mounting portions to said one mounting portion, for permitting said other mounting portion to be rotationally positioned with respect to said one mounting portion, for radially guiding said other mounting portion by operative contact of said circumferential surface with said first mounting portion, and for vertically restraining said other mounting portion; and

means (214+222+158 of FIGS. 8 and 11, 214+186+152 or 154 of FIGS. 8, 11, and 13, or 360+372+370 of FIGS. 14 or 18) for rotationally positioning said other mounting portion with respect to said one mounting portion.

2. A tower and rotationally positionable mount assembly (540 or 542) as claimed in claim 1 in which said assembly includes means (376 or 442) for electrically heating said second mounting portion (292 or 402).

3. A tower and rotationally positionable mount assembly (542) as claimed in claim 1 in which said tower (12) includes three vertically-disposed tower legs (20a–20c);

said assembly includes an antenna (412) that is operatively attached to said other (406) mounting portion; and

said assembly includes a reflecting device (454) that circumscribes said three tower legs, that is disposed radially intermediate of said tower and said antenna, that is operatively attached to one (402 of FIG. 19) of said mounting portions, and that is electrically connected to said antenna tower.

4. A tower and rotationally positionable mount assembly (538, 540, 542, or 544) which comprises a tower (12) including three tower legs (20a–20c), and having a neutral axis (26);

a first mounting portion (170+204 of FIG. 8, 328+342 of FIGS. 14–15, or 406 or 418 of FIG. 18);

a first segment (512a, 516a, or 456a) having a first arcuate surface (524a, 524b, 526a, 526b, 528a, or 528b), and having a first opening (530a) that is disposed radially inward of said first arcuate surface and that opens radially outward from said first segment distal from said first arcuate surface;

a second segment (512b, 516b, or 456b) having a second arcuate surface (524a, 524b, 526a, 526b, 528a, or 528b), and having a second opening (530b) that is disposed radially inward of said second arcuate surface and that opens radially outward from said second segment distal from said second arcuate surface;

a second mounting portion (142 of FIG. 8, 292 of FIG. 14, or 402 of FIG. 18), being disposed circumferentially around said three tower legs, and having a circumferential surface (152 or 154 of FIG. 12, 302 or 304 of FIGS. 14–15, or 432 or 434 of FIGS. 17–18) that includes both of said arcuate surfaces, that circumscribes said three tower legs, and that is disposed around an axis (24) that is substantially parallel to said neutral axis;

securing means (174+206 of FIG. 8, 352+354 of FIG. 14, or 404 of FIG. 18) for operatively securing one (170+204 of FIG. 8, 328+342 of FIGS. 14–15, or 402 of FIGS. 17–18) of said mounting portions to said tower;

attaching means, comprising a plurality of roller shafts (182, 188, 218, 310, or 334) that are operatively attached to said first mounting portion, comprising a plurality of rollers (160, 186, 219, or 306) that are attached to respective ones of said roller shafts, and comprising said circumferential surface, for supportingly attaching said other (142, 292, 406, or 418) mounting portion to said one (170+204, 328+342, or 402) mounting portion, for permitting said other mounting portion to be rotationally positioned with respect to said one mounting portion, for radially guiding said other mounting portion, and for vertically restraining said other mounting portion; and

means (214+220+158 of FIGS. 8 and 11, 214+186+152 or 154 of FIGS. 8, 11, and 13, or 360+372+370 of FIGS. 14 or 18) for rotationally positioning said other mounting portion with respect to said one mounting portion.

5. A tower and rotationally positionable mount assembly (540 or 542) as claimed in claim 4 in which one of said roller shafts (310 or 334) is disposed orthogonally and radially with respect to said parallel axis (24).

6. A tower and rotationally positionable mount assembly (538, 540, 542, 544) as claimed in claim 4 in which said second mounting portion (142, 292, or 402) includes a circumferential groove (150, 298, or 430) that includes an upper (152, 302, or 434) groove surface and a lower (154, 304, or 432) groove surface; and

said supportingly attaching of said other (142, 292, 406, or 418) mounting portion comprises one of said rollers (160, 186, 219, or 306) operatively engaging one of said groove surfaces.

7. A tower and rotationally positionable mount assembly (538, 540, or 542) as claimed in claim 4 in which said means for rotationally positioning said other mounting portion (142, 292, 418, or 406) comprises an electric drive motor (214 or 360) being operatively attached to said first mounting portion (204, 328, or 418), a plurality of gear teeth (158 or 370) being circumferentially disposed on said second mounting portion, and a toothed drive pinion (220 or 372) being opera-

tively attached (218, or 364+366) to said electric drive motor and progressively meshing with said gear teeth.

8. A tower and rotationally positionable mount assembly (538, 540, 542, or 544) as claimed in claim 4 in which said means for rotationally positioning comprises a drive motor (214 or 360) being operatively attached to said first (204, 328, or 418) mounting portion and operatively engaging (220+158 of FIGS. 8 and 11, 186+152 or 154 of FIGS. 11 and 13, or 370+372 of FIG. 14 or 18) said second (142, 292, or 402) mounting portion.

9. A tower and rotationally positionable mount assembly (538, 540, 542, or 544) as claimed in claim 4 in which said assembly includes a second (152 or 154, 302 or 304, or 432 or 434) circumferential surface; and

said means for vertically restraining comprises one of said circumferential surfaces.

10. A tower and rotationally positionable mount assembly (542 or 544) as claimed in claim 4 in which said first mounting portion (418) includes a ring-shaped mounting portion (406) that is disposed circumferentially around said tower; and

said ring-shaped mounting portion includes a third segment (520a), a fourth segment (520b), and means for connecting said third segment to said fourth segment.

11. A tower and rotationally positionable mount assembly (542 or 544) as claimed in claim 10 in which said securing of said one mounting portion to said tower (12) comprises securing said second (402) mounting portion to said tower.

12. A tower and rotationally positionable mount assembly (542 or 544) as claimed in claim 4 in which said other mounting portion comprises said first (418) mounting portion.

13. A tower and rotationally positionable mount assembly (542 or 544) as claimed in claim 12 in which said assembly includes a second (432 or 433) circumferential surface; and

said means for vertically restraining comprises one of said circumferential surfaces.

14. A tower and rotationally positionable mount assembly (542 or 544) as claimed in claim 12 in which said second mounting portion (402) includes a circumferential groove (430) that includes an upper (434) and a lower (432) groove surface; and

said circumferential surface comprises one of said groove surfaces.

15. A tower and rotationally positionable mount assembly (540 or 542) as claimed in claim 12 in which said means for rotationally positioning comprises a drive motor (360) being operatively attached to said other (418) mounting portion and operatively engaging (370+372) said one (402) mounting portion.

16. A rotationally positionable mount (504 of FIGS. 8–13, 506 of FIGS. 14–16, 508 of FIGS. 16–21, or 510 of FIG. 22) for attachment to a tower (12), for attachment of a device (256 or 266 of FIG. 8, 384 of FIG. 14, 416 of FIG. 17, 412 of FIG. 18, or 476 of FIG. 22) to said mount, and for rotation of said device around said tower, which rotatable mount comprises;

a first segment (512a, 516a, or 456a) having a first arcuately-shaped surface (524a, 524b, 526a, 526b, 528a, or 528b), having a first opening (530a) that is disposed radially inward of said first arcuate surface and that opens radially outward from said first segment distal from said first arcuate surface;

a second segment (512b, 516b, or 456b) having a second arcuately-shaped surface (524a, 524b, 526a, 526b, 528a, or 528b), having a second opening (530b)that is disposed radially inward of said first arcuate surface and that opens radially outward from said first segment distal from said first arcuate surface;

first mounting portion means (142 of FIG. 8, 292 of FIGS. 15–16, or 402 of FIGS. 17–18), comprising said first and said second segments, comprisng means for connecting said first segment to said second segment, and comprising a circumferential surface (152, 154, 302, 204, 432, or 434) that includes both of said arcuately-shaped surfaces, for providing a tower-receiving opening (548) that comprises said first and said second openings, and for tower-encircling assembly around said tower by moving said first and second segments transversely toward said tower;

second mounting portion means, including first, second, and third attaching portions (170+204, or 418), and comprising means (12 or 230 of FIG. 8, 12 of FIGS. 14–15, 406 of FIGS. 17–21, or 406 of FIG. 22) for determinately spacing said attaching portions;

attaching means, comprising said attaching portions, and comprising said circumferential surface, for supportingly attaching one (142 of FIG. 8, 292 of FIGS. 14–15, or 418 of FIGS. 17–18) of said mounting portion means to the other (170+204 of FIG. 8, 328+342 of FIGS. 14–15, or 402 of FIGS. 17–18) of said mounting portion means, for permitting said one mounting portion means to be rotationally positioned with respect to said other mounting portion means, for radially guiding said one mounting portion means by operative contact of said second mounting portion means with said first mounting portion means, and for vertically restraining said one mounting portion means; and

means (214+220+158 of FIGS. 8 and 11, 214+186+152 or 154 of FIGS. 8, 11, and 13, or 360+372+370 of FIG. 14 or 18) for rotationally positioning said one mounting portion means with respect to said other mounting portion means.

17. A rotationally positionable mount (504, 506, 508, or 510) as claimed in claim 16 in which said attaching means, and said radial guiding thereof, comprises a roller (160, 186, 219, or 306) that is radially restrained by said other attaching portions; and

said attaching means, and said radial guiding thereof further comprises said roller radially guiding said one mounting portion.

18. A rotationally positionable mount (504, 506, 508, or 510) as claimed in claim 16 in which said attaching means includes a plurality of roller shafts (182, 188, 218, 310, or 334) that are operatively attached to respective ones of said first, second, and third attaching portions;

said attaching means further comprises a plurality of rollers (160, 186, 219, or 306) that are operatively attached to respective ones of said roller shafts; and

said supportingly attaching of said one (142, 292, or 418) mounting portion means to said other mounting portion means (170+204, 328+342, or 402) comprises one of said rollers supportingly engaging said first mounting portion means.

19. A rotationally positionable mount (504, 506, 508, or 510) as claimed in claim 18 in which one of said mounting portion means (142, 292, or 402) includes a second circumferential surface (152, 154, 302, 304, 432, or 434); and

said vertical restraining comprises one of said circumferential surfaces.

20. A rotationally positionable mount (504, 506, 508, or 510) as claimed in claim 18 in which said first mounting portion (142, 292, or 402) includes a circumferential groove (150, 298, or 430) that includes upper (152, 302, or 434) and lower (154, 304, or 432) groove surfaces; and

one of said circumferential surfaces comprises one of said groove surfaces.

21. A rotationally positionable mount (504, 506, 508, or 510) as claimed in claim 20 in which said groove (150, 298, or 430) extends radially inward from a ring surface (148, 300, or 428) of said first mounting portion (142, 292, or 402);

said upper (152, 302, or 434) and lower (154, 304, or 432) groove surfaces diverge as said groove surfaces approach said ring surface;

one of said rollers (160, 188, 219, or 306) is profiled (162 of FIG. 10 or 316 of FIG. 16) to conform with said diverging of said groove surfaces; and

said radial guiding comprises operative engagement of said roller profile with said diverging grooves.

22. A rotationally positionable mount (504, 506, 508, or 510) as claimed in claim 18 in which said first mounting portion includes a second circumferential surface (152, 154, 302, 304, 432, or 434); and

said attaching means, and said radial guiding thereof, comprises one of said rollers (160, 186, 219, or 306) operatively engaging one of said circumferential surfaces.

23. A rotationally positionable mount (508 or 510) as claimed in claim 18 in which said means for determinately spacing said attaching portions (170+204, 328+342, or 418) comprises a ring-shaped mounting portion (406) that includes third (520*a*) and forth (520*b*) segments, and that includes means for connecting said third segment to said fourth segment.

24. A rotationaly positionable mount (508 or 510) as claimed in claim 18 in which said means for rotationally positioning comprises a drive motor (360) being operatively attached to said second mounting portion (418) and operatively engaging (370+372 of FIG. 18) said first mounting portion (402).

25. A method for mounting a device to a tower (12), which method comprises the following steps:

(a) placing first (456*a*) and second (456*b*) arcuate ring segments around said tower at a first height position thereof;

(b) connecting said first and second arcuate ring segments into a tower-retained ring (484) having first (458*a*) and second (458*b*) unconnected ends, after said placing step;

(c) moving said tower-retained ring upwardly to a guy wire (488);

(d) lifting one (458*a*) of said unconnected ends of said tower-retained ring above said guy wire;

(e) rotating said tower-retained ring with said one end of said tower-retained ring passing above said guy wire;

(f) moving said tower-retained ring to a desired height position;

(g) operatively securing said tower-retained ring to said tower at said desired height position; and

(h) operatively securing a device to said tower-retained ring.

26. A method as claimed in claim 25 in which said lifting step comprises rotating said one end (458*a*) upwardly with respect to the other (458*b*) of said ends around said connection (490) of said first (456*a*) and second (456*b*) arcuate ring segments.

27. A method for mounting a device (256, 266, 384, 412, or 416) to a vertically-disposed tower (12) having a neutral axis (26), and for rotationally positioning said device, which method comprises:

(a) moving a first arcuate segment (512*a*, 516*a*, or 456*a*) orthogonally toward said tower and into an arcuate relationship to said tower;

(b) moving a second arcuate segment (512*b*, 516*b*, or 456*b*) orthogonally toward said tower, into an arcuate relationship to said tower, and into a tower-encircling relationship with said first arcuate segment;

(c) interconnecting said arcuate segments into a ring-shaped first mounting portion (142, 292, or 402) that encircles said tower;

(d) providing a second mounting portion (170+204, 328+342, 406, or 418);

(e) operatively attaching one (170+204, 328+342, or 402) of said mounting portions to said tower; and

(f) rotatably attaching the other (142, 292, 406, or 418) of said mounting portions to said one mounting portion.

28. A method as claimed in claim 27 in which said rotatable attaching step comprises:

(a) supportively securing a plurality of circumferentially-spaced roller shafts (182, 188, 218, 310, or 334) to said second mounting portion (170+202, 328+342, or 406);

(b) operatively attaching a roller (160, 186, 219, or 306) to respective ones of said roller shafts; and

(c) supportingly engaging said first mounting portion (142, 292, or 402) with one of said support rollers.

29. A method as claimed in claim 27 in which said method further comprises:

(a) operatively attaching a drive motor (214 or 360) to said second (204, 328, or 418) mounting portion; and

(b) operatively engaging said drive motor with said first (142, 292, or 402) mounting portion.

30. A method as claimed in claim 27 in which said attaching of said second mounting portion (418) to said tower comprises:

(a) moving a third arcuate segment (520*a*) orthogonally toward said tower and into an arcuate relationship with said tower;

(b) moving a fourth arcuate segment (520*b*) into a tower-encircling relationship with said third arcuate segment; and

(c) interconnecting said third and fourth arcuate segments into a ring-shaped second mounting portion (406).

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